ASTM Bulletin

Next Month...

. . . see p. 14

EDITORIAL DEPARTMENT FB
UNIVERSITY MICROFILMS D6
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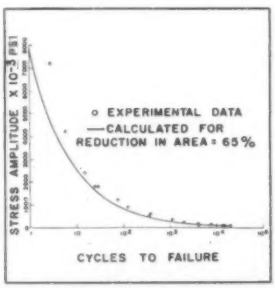
$$S = \frac{Ec}{2\sqrt{N}} + Se$$

A NEWLY DERIVED FORMULA FOR PREDICTING MATERIAL PROPERTIES . . . . . IN ADVANCE

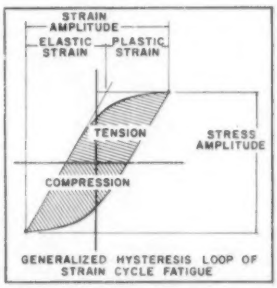
Instron is proud to have played a part in the development of a workable equation for predicting the low-cycle fatigue resistance of metals (and other materials). Low cycle fatigue deals with mechanical and thermal cyclic strain in materials from ¼ cycle up to approximately 10^5 cycles. Recent investigations have shown the tremendous importance of establishing reliable design criteria in this critical plastic strain range.

No — we can't take credit for the equation itself (which you can study at your leisure below.)* But we are responsible for the Instron Universal Tester, equipped with reverse stress cycling controls, which helped to prove that the equation was workable. Data obtained from low-cycle strain fatigue tests on 12 different materials, conducted on the Instron, corroborated the equation.

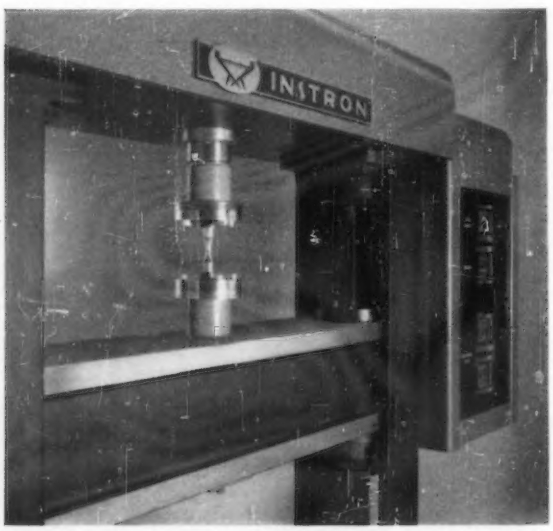
Which is yet another instance of what we mean when we say "you can do more with an Instron". If you have any problem at all related to materials testing, you should (at the very least) have the complete Instron catalogue. Also available: our ever-growing library of articles on advanced testing techniques, covering many fields. Yours for the asking — just mention your particular field of interest.



Typical curve (for 1018 carbon) shows correlation between Instron data (dots) and formula (solid lines).

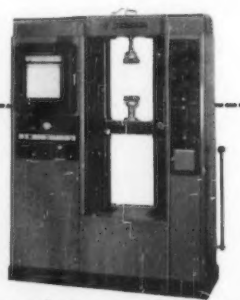


Generalized hysteresis loop of strain cycle fatigue.



Accuracy of cycling data provided by Instron Universal Tester furnished a reliable standard against which to check new formula.

* $S = \frac{Ec}{2\sqrt{N}} + Se$ — New formula for stress amplitude of a material is based on just 3 knowns, all easily arrived at by conventional test methods: 1) E, modulus of elasticity; 2) c, a constant easily related to the per cent reduction in area and 3) S_e, the endurance limit or yield stress point. N represents cycles to failure. Satisfactory correlation with experiments up to 10^5 cycles to failure was found. For more insight into this fascinating development, drop us a line.



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ASTM BULLETIN

December 1960 **Number 250**

Telephone: LOcust 3-5315 **Cable Address: Testing, Philadelphia**

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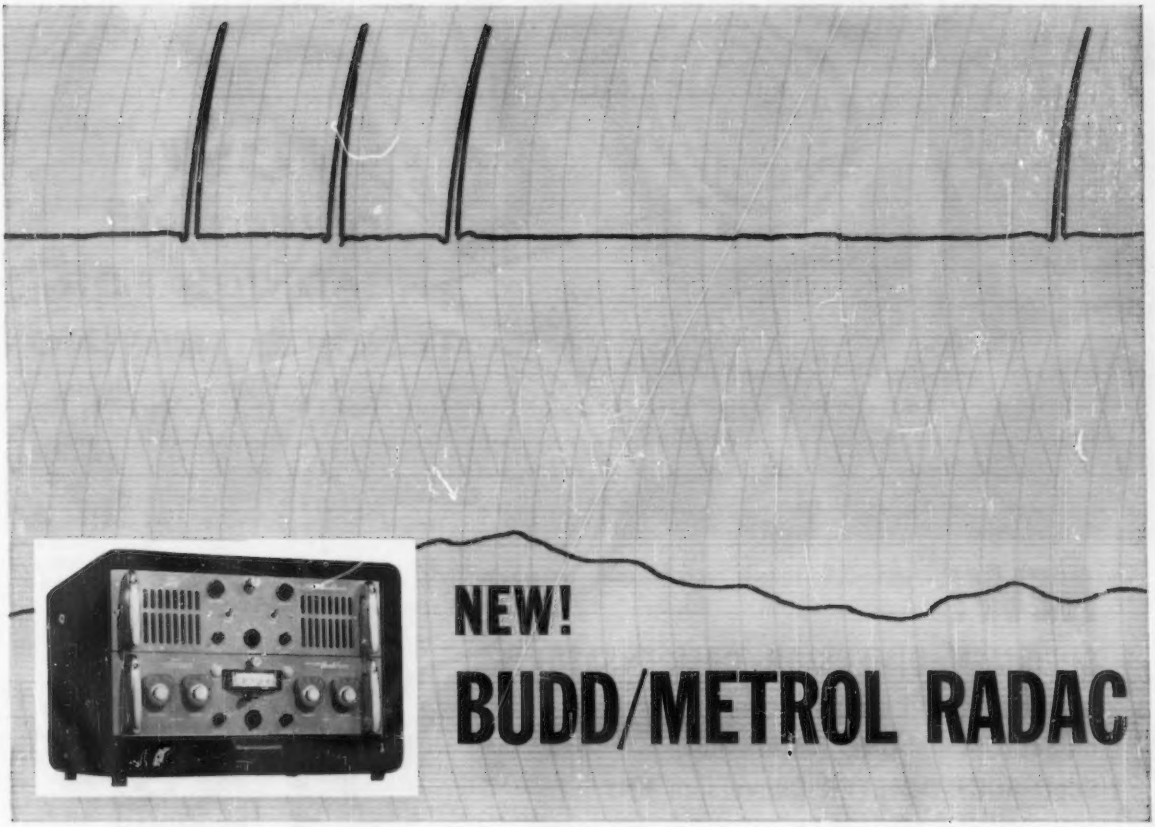

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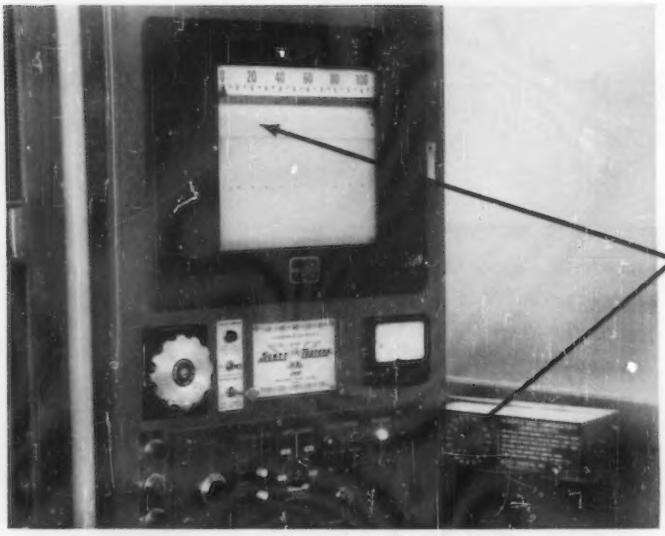

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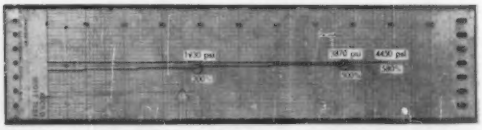

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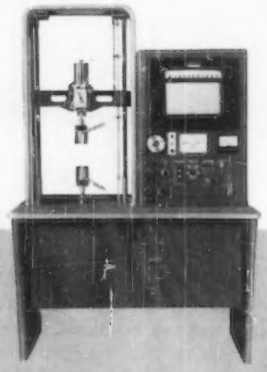

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ASTM BULLETIN

Research and Standards for Materials

Number 250 **December 1960**

Cincinnati To Be Scene of ASTM Committee Week

Symposium on Fire Test Methods Scheduled

THIRTY OF THE SOCIETY'S 85 main technical committees have scheduled meetings during ASTM Committee Week in Cincinnati, Ohio, at the Netherland Hilton Hotel, Jan. 30–Feb. 3, 1961. Approximately 1500 members, committee members, and visitors are expected to attend. The technical committees, subcommittees, and working groups will hold some 350 meetings in preparation for the Society's Annual Meeting in June.

Symposium on Fire Test Methods

Committee E-5 on Fire Tests of Materials and Construction will sponsor a Symposium on Fire Tests Methods on Wednesday, Feb. 1. A. F. Robertson, National Bureau of Standards, will preside. The following papers will be presented:

Early History of Fire Endurance Testing in the United States—Harry Shoub, National Bureau of Standards

A Treatise on Theoretical Fire Endurance Rating—T. Z. Harmathy, National Research Council of Canada

The New Beam Furnace at PCA and Some Experience Gained from Its Use.—C. C. Carlson and P. J. Tatman, Portland Cement Assn.

Surface Flammability of Materials—A Survey of Test Methods and Comparison of Results—J. A. Wilson, Factory Mutual Engineering Div.

Stream Pollution Expert to Speak

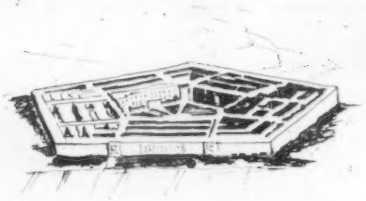
The Ohio Valley District has arranged for a dinner meeting on Wednesday, Feb. 1. The featured speaker and guest of honor will be Bernard B. Berger, chief of water supply and water pollution research, Robert A. Taft, Sanitation Engineering Center of the Department of Health, Education, and Welfare. Dr. Berger is a noted expert on stream pollution, and his talk will prove of considerable interest not only to those concerned with sanitation but also to industrialists and engineers in industries using large quantities of water. This topic is of particular interest to communities and industries in the Ohio Valley, which have pioneered in the area of proper use of our water resources.

The Ohio Valley District, under the chairmanship of Arba Thomas, Armco Steel Corp., Middleton, Ohio, has planned the dinner and the other social activities scheduled during the week. A Dutch treat social hour will precede the dinner.

These committees or their subcommittees have scheduled meetings . . .

Advisory Committee on Corrosion
A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-7 on Malleable-Iron Castings
A-10 on Iron-Chromium, Iron-Chromium - Nickel and Related Alloys
B-3 on Corrosion of Non-Ferrous Metals and Alloys
B-8 on Electrodeposited Metallic Coatings
C-7 on Lime
C-8 on Refractories
C-11 on Gypsum
C-12 on Mortars for Unit Masonry
C-15 on Manufactured Masonry Units
C-16 on Thermal Insulating Materials
C-22 on Porcelain Enamel
C-23 on Sorptive Mineral Materials
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-8 on Bituminous Materials for Roofing, Waterproofing, and Related Building or Industrial Uses
D-11 on Rubber and Rubber-Like Materials
D-21 on Wax Polishes and Related Material
D-22 on Methods of Atmospheric Sampling and Analysis
D-26 on Halogenated Organic Solvents
E-1 on Methods of Testing
E-5 on Fire Tests of Materials and Construction
E-7 on Nondestructive Testing
E-9 on Fatigue
E-12 on Appearance
E-15 on Analysis and Testing of Industrial Chemicals
E-17 on Skid Resistance
E-18 on Sensory Evaluation of Materials and Products

Materials Research for Defense



DOD report surveys the areas where greater knowledge of materials is urgently needed

"Elevated - temperature - test - procedure standardization needs urgent attention... Far too little attention has been paid to the identification of the properties of materials that are crucial to satisfactory performance under extreme conditions of temperature, strain, stress, radiation, etc.... There is an urgent need for very high-temperature-property data on solids, liquids, and gases... Basic studies are recommended to discover the laws of chemistry and physics that prevail in the temperature zone between the melting or decomposition points of the most refractory of known materials and indefinitely high upper limits such as 10,000 or 20,000 K... Test procedures for the determination of thermal conductivity, emissivity, and specific heat have not been standardized, thereby resulting in conflicting published data..."

THESE QUOTES are from a report[1] issued by the Department of Defense summarizing recommendations for research and development in materials. The office issuing the report is in a position to evaluate the over-all need for materials research so far as the national defense is concerned. Drawing freely on advisory reports issued by the Materials Advisory Board of the National Academy of Sciences–National Research Council and materials research symposia and conferences sponsored by various groups within the Department of Defense, the report probes a number of areas where ASTM committees are already diligently at work. But it also can be shown that the Society is challenged on several fronts.

[1] "Summary of Recommendations for Research and Development in Materials," prepared by The Office of Fuels, Materials and Ordnance, Office of the Director of Defense Research and Engineering, July 1, 1960, available from the Office of Technical Services, Washington, D. C. *PB 161865*, $1.50.

Problems of Testing and Analysis

The problems of testing and analysis in materials research programs form a continuous thread through the report. It is in this area, perhaps, that ASTM can contribute most toward the solution of materials problems. In the metals field, in particular, attention is called to the need for a test program to fill gaps in data on mechanical properties of high-strength ferritic steels in the temperature range of 150 to 800 F. In the low-temperature field, too, notch-toughness criteria are needed for correlation with service performance. In cryogenic programs, the report recommends that a "common denominator" test for notch impact strength (such as the Charpy V-notch impact test method E 23) be used for a direct comparison of data.

On the problem of brittleness, especially of refractory metals and ceramics, the report recommends that fundamental studies be continued on the mechanism of crack initiation and propagation, including the effects of plastic flow prior to crack initiation. Also, data are needed on the quantitative relation between strain rate and transition temperature for fracture of various materials, the quantitative relation between stress distribution and transition temperature, and the criterion of transition temperature most applicable to various types of service. Also, under the heading of brittle fracture, an earlier recommendation (1954) to technical societies and other groups was repeated—that they encourage and stimulate the study of brittle fracture at low temperatures by wide publication of appropriate technical papers and by preparing textual or handbook information for practical use.

One of the problems relating to studies and development of ultrapure materials is that of analyzing the material to ascertain the degree of purity. In some cases, the techniques developed for purification, such as vacuum melting, approach our ability to detect changes in composition, and further work on analytical techniques for metals and their impurities is needed.

Several specific recommendations concerning standardization of tests for materials included in the report are:

(1) With respect to precision steel aircraft castings, new and comprehensive quality standards are needed.

(2) There is no test, from the true statistical point of view, for the evaluation of steel quality for aircraft. Specifications in this area have employed the statistics for some applications and have discounted them in others.

(3) A continued effort should be made to develop and secure national standardization of test methods for organic materials, particularly: (a) for determining stress-strain data at rates that extend the upper range of present equipment to the order of ballistic loading; (*b*) for creep and stress-relaxation data, including standard methods of presentation; (*c*) for developing nondestructive tests of materials and construction, especially dynamic modulus and damping; (*d*) for developing methods of measuring thermal properties at temperatures significant in ablation—for example, specific heat, thermal conductivity, heat suffusion, and vaporization.

In commenting on the rather considerable amount of empirical research on materials required in connection with the defense effort in those areas where fundamental science has lagged, the report observes that little of this effort has been useful in revealing fundamental principles, mainly because insufficient information was available on testing procedures, conditions, and materials, or tests were not properly planned. More scientific work planning would add greatly to the value of such empirical studies; results could be compared with

and fitted into the existing framework of knowledge, and better interpolation and extrapolation from past experience would become possible. In brief, standardization of test methods will increase the usefulness of data to many investigators and would free research talent for more creative work.

Then, there is the opportunity for research in test methods. There appear to be wide differences of opinion of the value of many mechanical property tests and methods of conducting them. Research is needed to establish the significance of conventional tests with respect to the fabrication and use of components and to validate standardized testing methods. The report notes that a major problem in the use of materials is in the definition of requirements for design purposes in terms of uniformly accepted characteristics and measureable parameters.

Basic Research; Relation of Properties to Structure

The report urges that strong support be given to basic research and, in the field of polymers, points out the need for increasing the knowledge of (*a*) the thermodynamics of large molecules, (*b*) the relationship between structure and properties of polymers, (*c*) the phenomenon of fracture, (5) the adhesion between polymers and fillers, particularly of glass fibers, including the relationship of the surface treatment of fibers and their strength, and (*e*) the nature of parallel bonding systems.

In the field of refractory metals, recommendations are made for a fundamental program to study the behavior of dislocations on body-centered cubic lattices. This work might well include mechanisms of the generation and motion of dislocations, stacking fault phenomena, and the interaction of dislocations with interstitial elements.

Research on graphite is recommended, covering the production, properties, potentialities, and aggregating of graphite whiskers; the crystal structures and allotropic forms of graphite or carbon at high temperatures; and possibilities of interplaner bonding of graphite by the addition of other elements incorporated in the lattice.

In the field of ceramics, the report emphasizes the need for research on the inorganic chemistry of nonmetallic solids, including the study of high-temperature reactions, phase equilibria, and structure. Other research areas in the ceramics and refractories field include single-crystal studies, the effect of microstructure on the mechanical properties of ceramics for use as high-temperature structural materials, the effect of microstructure on electrical properties, electrical and out-gassing properties of ceramic materials for consideration as electrical insulators for high-temperature service, and test methods and equipment for evaluating materials for high-temperature use.

High-Purity Materials

A major research effort is indicated in the field of ultrapure materials. According to the report, facilities and programs should be established for the preparation of single crystals of experimentally useful dimensions, with very carefully characterized purity and perfection of structure, as well as pure polycrystalline or particulate structures.

It is noted that even the strongest materials available today have no more than one third of the strength predicted by theory. The emphasis toward high purity is widely regarded as a promising avenue toward correcting the indicated deficiency.

It is further recommended that the purity of materials should be correlated with their properties so that more data can be developed concerning the influence of controlled impurities on the physical and electrical properties of materials, together with how the latter may vary as a function of the former. The report points out that the rather profound effect of small quantities of certain elements can be evaluated only if accurate analytical methods can be developed simultaneously.

The subject of high-purity materials and the effects of impurities will be covered in a two session symposium at the ASTM 1961 Annual Meeting under auspices of the Division of Materials Sciences.

Rare Earths Show Promise

Great possible utility is anticipated for the rare earth elements. They have interesting metallurgical, chemical, thermal, electronic, and atomic properties. They are abundant in nature, and means of extraction are now available. But research is needed to evaluate their properties and to learn how they might be used to advantage. Some specific recommendations involving research on the rare earths include studies of rare earth additions for dispersion hardening of refractory metals, their relative scavenging ability, studies of high-temperature properties of rare earth compounds, including melting points, vapor pressure at high temperature, density, ductility, thermal conductivity, and expansion, and other thermal properties. Properties should be measured for the borides, carbides, nitrides, silicides, sulfides, oxysulfides, and oxides. The rare earth tellurides, selenides, bismuthides, and antimonides have been evaluated as semiconducting materials, but more research is needed. There is promise of high-temperature stability. Other areas for investigation of the rare earth elements include studies of magnetic properties and use of their oxides for precision polishing compounds for optical glass.

In the field of thermoelectric materials, a number of recommendations for research are made. In particular, one important area requiring study is the thermal conductivity of these materials at high temperatures, particularly in development of better measurement techniques at temperatures above 500 C.

Problems of Joining and Fastening

Problems of joining by welding, brazing, riveting, adhesive bonding, etc., are also covered in the report. It is pointed out that the high-temperature alloys are particularly difficult to weld, braze, and join, and the changes in microstructure produced by welding heat can be detrimental to properties. Welding research is needed on: welding thin-gage sheet, especially steels for sandwich construction; welding heavy sections 1 to 8 in. thick; the welding metallurgy of metals, especially stainless and high-temperature alloys; welding of high-tensile steels of 250,000 psi and higher; and improvement of testing and inspection procedures and methods to evaluate service performance of weldments. Recommendations are made for research on adhesives, and the point is made that adhesive bonding is usually less expensive than welding or brazing. The need for adhesives stable at high temperatures is indicated.

Other subjects discussed in the report included plasma phenomena, sandwich constructions, coatings, deterioration of materials and structures, as well as problems of fabrication, including forming, casting, metal stock removal, and heat treating.

F.Y.S.

1961 Book of Standards To Be in Eleven Parts; Part 9 To Be Divided

Board of Directors Raises Charges for Book

THE RAPID GROWTH of the Society's activities in the fields of plastics and electrical insulation during the past three years has outrun predictions made in 1957 and 1958. As a result, the size of Part 9, which contains standards on plastics, electrical insulation, rubber, and carbon black, has grown to exceed the economical limits of machine binding, and has become very unwieldy, making it necessary to divide Part 9 for the 1961 edition. Part 9 will continue to contain standards on plastics and carbon black. The new Part 11 will contain standards on electrical insulating materials, rubber, and the added subject, electrical insulating liquids and gases. (NOTE.—We know that liquids and gases are materials, but the redundancy may be forgiven because liquids and gases as insulating materials are opening new fields for high-voltage cable transmission.)

All members who get Part 9 now have been asked by special letter to advise Society Headquarters whether they wish to continue to receive Part 9, shift to Part 11, or receive both parts. If they choose to receive both parts, they will then pay an added annual charge on a continuing annual basis as they do for other parts they receive over the one part to which they are entitled on their dues.

Board of Directors Increases Book of Standards Charges

After careful scrutiny of the Society's financial operations by the Finance Committee and the Board of Directors, action was taken by the Board on September 13 to raise the annual charge made for parts of the Book of Standards, other than the one part furnished without charge on the member dues, from $3 to $6 per part per year. This is the first increase for this annual charge in nine years. As with most operations, the cost of operating the Society is on the increase, and, since printing and publication costs have increased drastically in the last few years, the need for these changes is evident.

The prices for Books of Standards sold on other than the annual-charge basis have increased modestly as the size of the Book has increased, but they have not kept pace with increased costs, and the Board acted to set the prices more in line with the true costs of the Book and its value. The prices on a per-page basis are still modest, indeed, when compared with the price of comparable reference texts and handbooks. The Board of Directors feels that the membership of the Society and industry will support these prices, recognizing as they do the great and growing importance of ASTM's contribution through voluntary standards to the country's economy.

The accompanying table summarizes the subject matter of the 1961 Book of Standards and the prices established. For the first time, a discount for buying a complete set is offered.

1961 Book of ASTM Standards To Be in 11 Parts

COMPARISON OF CONTENTS

Contents of 1958 Book, 1959 and 1960 Supplements	Contents of 1961 Book	Price of 1961 Book List	Price of 1961 Book ASTM Member
Part 1—Ferrous Metals Specifications (Except Test Methods)	Same as 1958	$23.00	$18.50
Part 2—Non-ferrous Metals Specifications (Except Test Methods), Electronic Materials	Same as 1958	21.00	17.00
Part 3—Methods of Testing Metals (Except Chemical Analysis)	Same as 1958	14.00	11.00
Part 4—Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils	Same as 1958	21.00	17.00
Part 5—Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests	Same as 1958	17.00	13.50
Part 6—Wood, Paper, Adhesives, Shipping Containers, Cellulose, Leather, Casein	Same as 1958	17.00	13.50
Part 7—Petroleum Products, Lubricants, Tank Measurements, Engine Tests	Same as 1958	23.00	18.50
Part 8—Paint, Naval Stores, Aromatic Hydrocarbons, Coal and Coke, Gaseous Fuels, Engine Antifreezes	Same as 1958	23.00	18.50
Part 9—Plastics, Electrical Insulation	Plastics, Carbon Black	14.00	11.00
Part 10—Textiles, Soaps, Atmospheric Analysis, Wax Polishes, Water	Same as 1958	23.00	18.50
Part 11—	Electrical Insulating Materials, Rubber, Electrical Insulating Liquids and Gases	21.00	17.00
Price per complete set		$195.00	$156.00

1960 Year Book Mailed

Retain Your 1959 Book for Geographic Listing of Members

The 792-page 1960 Year Book, listing our 10,500 members and the personnel of our 87 technical committees and 2000 subcommittees, was mailed on December 16 to all those who returned their request blanks. If you returned your request blank and have not received your Year Book, please advise ASTM Headquarters.

Subcommittee personnel in even years only

On instruction of the Board of Directors, the complete personnel of subcommittees is published every other year—in the even-numbered years. The Year Book in odd-numbered years will contain only a listing of subcommittee names and their officers after the complete main committee personnel. The 1960 Year Book therefore contains the complete subcommittee personnel.

Geographic listings in odd years only

We have also been instructed to include the geographic listing of members every other year—in the odd-numbered years. It is therefore suggested that this section of the 1959 Year Book be retained until the 1961 Year Book becomes available.

Mineral Aggregates and Concrete

Compilation of Standards, C-9, D-4

THE VAST NATIONAL highway construction program now under way has spurred wider usage of standards on highway materials and has also stimulated research and testing of these materials. The resulting new standards as well as the many revisions of existing standards have prompted the publication of a new edition of "ASTM Standards on Mineral Aggregates and Concrete, with Selected Highway Materials."

Additional standards in the new edition include a recommended practice describing procedures for microscopical determination of air-void content, specific surface, and spacing factor of the air-void system in hardened concrete (C 457); a specification for cotton mats to be used in curing concrete pavements, bases, and other structures (C 440); a method of test for effectiveness of mineral admixtures in preventing excessive expansion of concrete caused by reaction between aggregates and alkalie in portland-cement mixtures (C 441); specifications for preformed expansion joint fillers for nonextruding and resilient bituminous types (D 1751); and specifications for nonextruding and resilient nonbituminous types (D 1752).

Of the 100-odd standards appearing in the September, 1958, edition, 31 have been revised. This has more than justified publication of the new edition.

This publication is sponsored by Committees C-9 on Concrete and Concrete Aggregates and D-4 on Road and Paving Materials. It includes all the standards for concrete and concrete aggregates, but only those for selected nonbituminous highway materials or those involving aggregate gradings or tests. The edition includes the pertinent specifications for cement as well as reference to specifications on concrete reinforcement bars.

ASTM *Standards on Mineral Aggregates and Concrete* (with Selected Highway Materials), 396 pages, hard cover, price $5.75, to members $4.60.

Price Set for Radiation STP

THE AVAILABILITY of this symposium volume was announced in the October issue of the ASTM Bulletin, however the price of the book had not yet been set. The size and price of this volume are:

STP 268, Applied Radiation and Radioisotope Test Methods, 112 pages, hard cover, price $3.75, to members $3.00.

Book Order Form

American Society for Testing Materials
1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send postpaid copies of the following publications for which I enclose $.....

..... copies **Applied Radiation and Radioisotope Test Methods, STP 268**
..... copies **Mineral Aggregates and Concrete, Compilation of Standards (C-9, D-4)**
..... copies **Elevated Temperature Properties of Aluminum and Magnesium Alloys, STP 291.**

Name .....
Company .....
Address .....

☐ **ASTM Member**
☐ **Please bill with shipment**

Supplements to Book of Standards: 3 of 10 Parts Now Available

THE 1960 SUPPLEMENTS to the 1958 Book of Standards are being published in ten parts in heavy paper covers. They include new and revised standards and tentatives adopted or accepted at the 63rd Annual Meeting or by the Administrative Committee on Standards. Parts 3, 6, and 8 are available now; parts 2, 4, and 7 will be available shortly. In the following list, the parts now available are shown in boldface type.

Part 1—Ferrous Metals (Specifications)
Part 2—Non-ferrous Metals (Specifications), Electronic Materials
Part 3—Methods of Testing Metals (Except Chemical Analysis)
Part 4—Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils
Part 5—Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests
Part 6—Wood, Paper, Adhesives, Shipping Containers, Cellulose, Leather
Part 7—Petroleum Products, Lubricants, Tank Measurements, Engine Tests
Part 8—Paint, Naval Stores, Aromatic Hydrocarbons, Coal and Coke, Gaseous Fuels, Engine Antifreezes
Part 9—Plastics, Electrical Insulation, Rubber, Carbon Black
Part 10—Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes

Elevated Temperature Properties of Aluminum and Magnesium Alloys

THE AVAILABILITY of this volume was announced in the September issue of the ASTM BULLETIN, however the price of the book had not yet been set. This publication, sponsored by the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals, summarizes elevated-temperature, tensile, and creep-rupture properties of current commercially established alloys.

The size and price of this book are: *STP 291, Elevated Temperature Properties of Aluminum and Magnesium Alloys*, 314 pages, 8½ by 11 in., heavy paper cover, price $7.00, to ASTM and ASME members $5.60.

"... the public pressure for 'results' can lead to the overorganization of science. One of the most popular, and one of the most ruinous, assumptions about science is that it normally achieves its practical results by aiming directly at them. Much more often than not, significant advances in science have been made precisely when men have had the sense of disengagement from urgent pressures that has allowed them to ruminate, to roam around, and to work on problems in which no practical man was interested."

Charles Frankel, "We Must Not Let Moscow Set Our Pace," *The New York Times Magazine*, Oct. 2, 1960.

Actions on Standards

THE ADMINISTRATIVE COMMITTEE ON STANDARDS is empowered to pass on proposed new tentatives and revisions of existing tentatives, tentative revisions of standards, and the withdrawal of tentatives and standards offered between Annual Meetings of the Society. With two exceptions the Standards Committee took the following actions on Sept. 29, 1960. The action relating to Definitions for Soil Dynamics (D 1707) was taken on Sept. 16, 1960, and action on a portion of the revision of Definitions for Emission Spectroscopy (E 135) was taken on Sept. 22, 1960. Anyone interested in securing copies of the standards should write to Headquarters regarding their availability.

Plastics

Tentative Specification for Poly(Vinyl Chloride) Resins (D 1755–60 T)

New Tentative.—This specification provides a means of establishing requirements for homopolymers of vinyl chloride in original powder form intended for subsequent mixing and processing in thermoplastic compositions. Two types of resin are covered: Type GP, which are general-purpose resins primarily intended for either dry blending, preblending, or thermoplastic processing; and Type D, which are dispersion resins primarily intended for use in organosols and plastisols.

Tentative Specification for Epoxy Resins (D 1763–60 T)

New Tentative.—This specification covers totally reactive epoxy resins supplied as fairly viscous to miscous liquids which can be used for casting, tooling, and potting, and which also can be formulated to produce adhesive and laminating compositions. They can also be used as stabilizers and cross-linking agents, and they can be combined with other reactive products.

Tentative Method of Test for Transparency of Plastic Sheeting (D 1746–60 T)

New Tentative.—Plastic films and other transparent sheet materials are often rated for clarity by their effect on visual resolution of objects seen through them. This method of test was developed to meet the need for an objective measurement of this visual phenomenon. Together with standard measurement for gloss, haze, and color, significant optical properties of plastic films may now be described objectively.

Tentative Specification for Polyethylene Molding and Extrusion Materials (D 1248–59 T)

Revised.—A significance section has been added to provide warning against the growing tendency on the part of many in the plastics industry to misuse the values in Table II (Detail Requirements for Molded Test Specimens) for engineering design purposes to which these values are unsuited.

Tentative Method of Test for Resistance of Plastics to Chemical Reagents (D 543–56 T)

Revised.—The method has been updated from the standpoint of reagents and exposure techniques and conditions. More specific provisions have been provided for determining the effect of chemicals on the mechanical properties of plastics.

Tentative Method of Test for Carbon Black in Ethylene Plastics (D 1603–58 T)

Revised.—Alternate methods for safeguarding the purity of the nitrogen have been added.

Tentative Definitions of Terms Relating to Plastics (D 883–60 T)

Revised.—Definitions have been added for virgin material, organosol, asbestos reinforcement, allyl plastics, cell, cellular plastic, chemically foamed plastic, closed cell foamed plastic, expandable plastic, expanded plastic, foamed plastic, mechanically foamed plastic, open cell foamed plastic, plastic foam, thermally foamed plastic, cellular striation, collapse, fissure, skin, void, and elasticity.

Standard Methods of Test for Specific Gravity of Plastics (D 792–50)

Revised and Reverted to Tentative.—The format of the methods has been brought into line with the recommended form, and a report section was added.

Tentative Method of Test for Pentosans in Cellulose (Orcinol Colorimetric) (D 1787–60 T)

New Tentative.—This method of test covers the procedure for determining pentosans in cellulose by the orcinol colorimetric method, in the range from less than 1 to about 16 per cent. The method, developed in Sweden, was tested cooperatively, and reasonable results were obtained by several collaborators on 10 samples of pulp.

Tentative Method of Test for Pentosans in Cellulose (Aniline Acetate Colorimetric Method) (D 1438–56 T)

Withdrawn.—This method is being replaced by the new Method D 1787 referred to above, since cooperative testing has found Method D 1787 to be more precise.

Omission from Society Letter Ballot

A RECOMMENDATION of Committee C-17 on Asbestos-Cement Products to adopt tentative revisions of Sections 4(*b*) and 14(*c*) of the Standard Specifications and Methods of Test for Asbestos-Cement Siding Shingles and Clapboards (C 223–55) was omitted from the Letter Ballot of the Society. In view of the nature of the revisions and the fact that they had complete clearance in Committee C-17, it is proposed to proceed as if the recommendation had been officially cleared in the regular manner, unless objection is raised. Please advise Headquarters promptly of any objections.

Steel

Tentative Specification for:

Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service (A 216–59 T)

Alloy-Steel Castings for Pressure-Containing Parts Suitable for High-Temperature Service (A 217–59 T)

Ferritic and Austenitic Steel Castings for High-Temperature Service (A 351–60 T)

Ferritic Steel Castings for Pressure-Containing Parts Suitable for Low-Temperature Service (A 352–59 T)

Alloy-Steel Castings Specially Heat Treated for Pressure-Containing Parts Suitable for High-Temperature Service (A 389–59 T)

Revised.—Spectrochemical methods for quantitative analysis of steel castings are permitted by this revision.

Tentative Specification for Welded Austenitic Stainless Steel Boiler, Superheater, Heat Exchanger, and Condenser Tubes (A 249–60 T)

Revised.—Grade TP 305 steel has been added, and other changes have been made to reflect current practice.

Tentative Specification for:

Carbon and Alloy-Steel Forgings for Magnetic Retaining Rings for Turbine Generators (A 288–57 T)

Carbon and Alloy-Steel Forgings for Turbine Generator Rotors and Shafts (A 292–59 T)

Carbon and Alloy-Steel Forgings for Turbine Rotors and Shafts (A 293–59 T)

Carbon and Alloy-Steel Forgings for Turbine Bucket Wheels (A 294–57 T)

Revised.—The provisions of these specifications have been brought into conformance with present industry practice, and they are presented in a new format.

Standard Specifications for Alloy-Steel Forgings for Nonmagnetic Coil Retaining Rings for Turbine Generators (A 289–55)

Revised and Reverted to Tentative.—The provisions of these specifications have been brought into conformance with present industry practice, and they are presented in a new format.

Wrought Iron

Standard Definitions of Terms Relating to Wrought Iron (A 81–33)

Revised and Reverted to Tentative.—The definition for slab pile has been changed to bar pile, and definitions have been added for slab pile and for single refined iron.

(*Continued on p.* 19)

Materials Sciences

Challenge of the Materials Age

Anyone wishing to see the broad view of materials science and technology will be interested in the treatment given this subject in the September issue of *Materials in Design Engineering*. The editors of the magazine have assembled the opinions of experts concerning the present deepening of our concepts of materials from an empirical to a scientific level. Contributors to the special feature include Prof. Harvey Brooks of Harvard University; Prof. J. A. Krumhansl, Cornell University; William J. Harris, Jr., National Academy of Sciences; Prof. L. H. Van Vlack, University of Michigan; and the editors of *M/DE*. The feature includes articles on solid-state science, materials engineering and research, materials education, the materials information problem, and new projects in the technical societies. This special feature is recommended reading for all who have more than a passing interest in the science and technology of materials.

Perspectives in Materials Research

What is the present state of knowledge of materials? what are the critical problems now limiting our understanding of the behavior and properties of materials? and what approaches hold the greatest hope for solving these problems? These questions will be asked and answered, to the best of the ability of the most able scientists in eleven different subject areas, by panels organized by the National Academy of Sciences–National Research Council, under the chairmanship of Prof. Frederick Seitz, University of Illinois.

Eleven panels have been organized on: Mechanical Behavior of Solids; Phase Transformation in Solids; Cohesive Properties of Solids; Diffusion and Mass Transport; Surface Phenomena; Magnetism and Magnetic Properties; Electrical, Thermal, and Optical Properties of Materials; Effects of Radiation on Materials; Structure and Properties of Liquids; Techniques and Instrumentation; and Growth, Morphology, and Structure of Crystals.

The study is concerned primarily with the intrinsic and structure-sensitive properties of materials and particularly with the relationships between structure (electronic, atomic, crystallographic, imperfection, metallurgical, etc.) and properties. Emphasis is on the basic physical and chemical behavior of materials and not on the more applied areas. Nevertheless, the significance of fundamental scientific concepts to the understanding of the complex behavior of real materials will be stressed wherever possible. Results of this study will be published in book form.

Materials Education

In cooperation with the American Society for Engineering Education, the Society sponsored a Symposium on Education in Materials at the Annual Meeting in 1959. The papers have been published as *STP 263*. As the authors of those papers pointed out, the problems of education in materials are becoming increasingly acute because of the recent shift from an empirical or semi-empirical approach to that of syntheses based on fundamental principles of the physical sciences. The engineer of the future, will, perhaps, design and specify the building of required materials to order. This requires an integrated treatment of some aspects of the physical sciences as "materials technology."

These changes are world-wide, and educators everywhere are concerned with them. A thoughtful and well documented article entitled "Materials Technology" appeared in the September issue of the *Journal of Scientific and Industrial Research* (India). The author, S. V. Chandrashekhar Aiya, Indian Institute of Science, Bangalore, points out that materials research directed toward relating the physical and chemical properties of a material to its constituent atoms and molecules and their relative configuration and structure was, by and large, the work of pure scientists whose sole object was to extend the boundaries of knowledge. The engineer, with his professional responsibility to use the scientific method, where possible, in the analysis and solution of engineering problems, must now know more science, particularly materials science.

Seven ASTM Members Among Those Recognized at SES Meeting

At the Ninth Annual Meeting of the Standards Engineers Society, held in Pittsburgh, Pa., Sept. 26–28, awards were presented to individuals for service to standardization and to the society. The society's highest award of Honorary Life Fellow was presented, *in absentia*, to James G. Morrow, ASTM Honorary Member and past-president.

Four ASTM members and committee members were awarded fellowships in recognition of their high standing in the standards profession. They are Leslie D. Price, manager, Engineering and Safety Regulations Dept., National Electrical Manufacturers Assn.; David Wolochow, secretary, Canadian Government Specifications Board; Fulton R. Magill, manager, Central Standards Dept., Rockwell Manufacturing Co.; and Lal C. Verman, director, Indian Standards Institution.

N. L. Mochel *(left, above)* and A. C. Webber *(left, below)* receive their SES-ASTM awards from SES past-president M. S. Gokhale.

Norman L. Mochel received the SES-ASTM award for outstanding service in standardization. Mr. Mochel, an ASTM past-president, is manager of metallurgical engineering, Westinghouse Electric Corp., Philadelphia, Pa. He has served the Society in many capacities over the years, and is currently chairman of the strategic Long-Range Planning Committee.

The SES-ASTM award for outstanding contributions to the literature of standardization was presented to Alfred C. Webber, ASTM national director, chairman of Committee E-1 on Methods of Testing, and vice-chairman of Committee D-20 on Plastics. As senior supervisor in the Research and Development Div. of the Polychemicals Dept. at du Pont's Experimental Station, Mr. Webber has initiated, directed, and reported upon studies leading to the development of many of the plastics industry's standard test methods and specifications.

The Labor of Technical Writing

BY WALTER J. SMITH[1]

FOLLOWING THE accomplishment of each research, investigational, or study assignment there is usually the need to prepare a report or paper of one kind or another. Very often, realization of the value of results from this work is highly dependent upon the effectiveness of the report. This places a heavy responsibility upon its author. To some extent, it may be on this account that many find the writing of the technical report to be a very difficult, exacting, and laborious task. Yet the pain and trouble of report writing is seldom discussed; usually it is overlooked or ignored entirely. Perhaps it is time to give the matter some open consideration.

A first reaction may be that this subject is of small importance and applies only to an unhappy few who should have learned better how to write. When we consider, however, the expanding files in laboratories and offices of research and development activities, the increasingly voluminous technical literature, and the growing abstract services, the size of the problem becomes apparent. An enormous amount of money and talent is being poured into the work represented by this literature, and the information so developed is vital to progress in science and industry. Any restriction that impedes the flow or impairs the quality of this information is indeed a problem, and one of first-order importance.

To understand the trials of a report author is not simple. There are those who explain that technical writing is made difficult by limitations of a language inherited from a nontechnical past. There may be some truth in this, but the complaint is largely offset by introduction of the more precise symbols and terminology of science and by the use, where necessary, of the exact language of mathematics.

A more likely reason is that the writer tries to outdo himself. Accomplished writers are rare in any case. Yet the technical author may feel that the importance of his work requires an exceptionally fine piece of writing. Then he has a problem. Since no one likes to admit an inadequacy, he is inclined to labor away prodigiously without complaint.

Many employers and supervisors fail to realize the difficulty and magnitude for most people of report preparation. The result is that too little time and inadequate facilities are provided. Under such conditions it is very common for reports and papers to be written at home and outside of business hours. An understanding employer will allow this time to be taken at home during office hours so that the writing may be done properly and without interference.

In one case, at least, a company has provided several noise-free rooms called "Think Cells" where an engineer may sit at a desk to work out a problem or write. To be effective, such rooms should be of sacred solitude and free from telephone and intercom.

Especially in large organizations it is becoming more common to provide professionally trained editorial assistance to technical authors. This is enormously helpful, of course, and serves the double purpose of assuring better quality of report language and arrangement while helping authors to improve their own capabilities. One must be careful in this case that the author does not rely too heavily on the editor. Certainly the original draft must be prepared by the author before any improvements are attempted by others—only he knows what he wants to say. Furthermore, the hardest part of a first draft is thinking through the subject and organizing it in an outline. This is the author's responsibility and cannot be delegated to an editor.

More helpful than anything else would be a greater general awareness of the importance and highly practical need for better developed writing competence among scientists and engineers. This takes us directly back to the classroom. With rather few exceptions, the effort in technical schools and colleges is toward providing the student with understanding and knowledge in specific subjects. Later, in practice, this enables him to produce good professional results of his own. All too often, it is only then that he discovers his need for a better ability to write. Greater emphasis must be given to this whole matter of self-expression during the course of technical education and training. Only in this way can this half-hidden problem be met in proper fashion. Technical development and output is the lifeblood of our present economy and of the future. Nothing must be allowed to hamper its flow.

[1] Chemical Engineer, Arthur D. Little Co., Cambridge, Mass.

Plastics Leads the Field in ISO Standards Output

A PRACTICAL BASIS for simplifying and increasing international plastics trade took another important step toward realization in November as the International Standards Organization's Technical Committee on Plastics (ISO/TC 61) completed its tenth annual week-long meeting, in Prague, Czechoslovakia.

With competition for American industry sharpening, particularly among Europe's highly successful common markets, the inner six and outer seven, ISO/TC 61 standards become the working tools for our competing on a par with other nations. Producers and consumers alike find internationally agreed methods, specifications, and terminology useful, both in international trade and in their own national standards work. In addition, the exchange of purely technical information, apart from commercial work, is smoother, simpler, and less expensive.

With these ideas in mind, the 113 delegates from 15 nations approved for ballot three more methods of test for plastics, bringing to 36 the total of draft ISO Recommendations sanctioned by TC 61. Six more methods are in process.

Results of this meeting, according to W. E. Brown, Dow Chemical Co., chairman of ISO/TC 61, show once again that the plastics committee holds a "front-running position as the most productive of the 97 ISO committees dealing with the whole range of industrial products and processes."

Procedure for Determination of Tetraethyllead in Gasoline[1]

Comparison of ASTM Method D 526[2] and GOST-63

The program to compare the suitability of ASTM Method D 526[2] (ASA Method Z11.48) and of the Russian Procedure GOST-63 for determination of tetraethyllead in gasoline is completed. Thirteen laboratories participated in the analyses of five samples representative of typical gasolines of different characteristics and containing different amounts of tetraethyllead.

Data

Since both the ASTM and the Russian methods are being considered for international standardization, precision of testing is the main evaluation factor. The 13 laboratories therefore made duplicate analyses of the five samples by both methods. The data and average values are listed in Table I. Laboratory 11 did not test by Method D 526.

The laboratories were also asked to comment on analytical time, over-all time for the program, and the preferred method, see Table II. Other pertinent comments are listed in Table IV.

Precision

The precisions of ASTM Method D 526 and of Russian Procedure GOST-63 were calculated from the experimental data in Table I by using the "Proposed Recommended Practices for Applying Precision Data Given in ASTM Methods of Test for Petroleum Products and Lubricants."[3] Reproducibility and repeatability values are listed in Table V.

The precision found for ASTM Method D 526 is approximately the same as stated in the method. In some cases precision is a little better and in others not so good, but there are no marked differences. The reproducibility for sample 60-2 seems erroneous, but the experimental data reported by laboratory 8 are considerably at variance with those from the other participants. When results from laboratory 8 for sample 60-2 are omitted, the calculated reproducibility of this sample agrees very well with that stated in the method.

Precision for ASTM Method D 526 is much better than for the GOST-63 procedure, the difference being more pronounced for reproducibility than for repeatability, Table V. In every case the reproducibility of GOST-63 procedure is inferior to that of ASTM Method D 526. The repeatability of Method D 526 is better than that of GOST-63 for samples 60-1, 60-3, and 60-5. There is no statistical reason to believe a difference in repeatability exists between the two methods for samples 60-2 and 60-4.

To ascertain whether either method is of limited application in its scope, the program purposely included samples containing catalytically cracked materials, 60-1, 60-3, and 60-5 and samples of straight-run products 60-2 and 60-4. The data in Table V clearly indicate that GOST-63 is not well suited for determining tetraethyllead content in samples of catalytically cracked materials. The precision of the test is much poorer than for the two samples of straight-run products. ASTM Method D 526 is not influenced by sample type.

Accuracy

The tetraethyllead content of each of the five test samples was prepared by dispensing the fluid from a volumetric buret into approximately 30 lb of the gasoline which had been weighed accurately. The actual quantities of tetraethyllead added to the samples are listed in Table V. For Method D 526 the amounts found, as indicated by the grand averages, compare very favorably with the amounts actually present. For the GOST-63 procedure the amounts found for samples 60-1, 60-3, and 60-5 are definitely too low. Thus, there is accuracy evidence which indicates that the GOST-63 procedure is not applicable to catalytically cracked gasolines.

Analytical Time and Preferred Procedure

The participants were about evenly divided on the question of which method is faster (Table II). They did agree, however, after reviewing all the data, that Method D 526 is the more precise method.

A number of other interesting comments were reported and are tabulated in abbreviated form in Table IV. Many of the comments were reported by more than one laboratory.

Other Procedures

Eight of the cooperating laboratories also reported values by methods used routinely in their respective laboratories. The data are listed in Table III. X-ray procedures were used in five cases, the polarograph in two, and versenate titration in one. Most of the results are in good agreement with the grand average values found for Method D 526 and with the actual tetraethyllead present.

Conclusions

The poorer order of precision of the GOST-63 procedure, especially when used on catalytically cracked gasolines containing tetraethyllead, and the demonstrated applicability of ASTM Method D 526 to all types of commercial motor gasolines containing tetraethyllead, dictates a definite preference for ASTM Method D 526.

Recommendation

It is recommended that ASTM Method D 526 be selected as the basis of an ISO recommendation.

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[1] Prepared by R. K. Siegfriedt, Socony Mobil Oil Co., Inc., Brooklyn, N. Y., for Section B of Research Division III of ASTM Committee D-2 on Petroleum Products and Lubricants. The members of Section B are: J. B. Rather, Jr., Socony Mobil Oil Co., Inc., chairman; R. E. Borup, Cities Service Research and Development Co.; F. R. Bryan, Ford Motor Co.; L. W. Burdett, Union Oil Company of California; W. V. Cropper, Standard Oil Co. (Indiana); G. V. Dyroff, Esso Research and Engineering Co.; George Entwistle, Sinclair Refining Co.; C. M. Gambrill, Ethyl Corp.; G. N. Griffiths, British Petroleum (North America) Ltd.; W. C. Hamilton, Continental Oil Co.; B. J. Heinrich, Phillips Petroleum Co.; G. D. Hoggan, Richfield Oil Corp.; Howard Jones, United States Air Force; W. H. Jones, Esso Standard, Division of Humble Oil and Refining Co.; L. Mittelman, Tidewater Oil Co.; B. E. Nagel, General Motors Corp.; W. T. R. Pierce, Sun Oil Co.; D. C. Roberson, Standard Oil Co. (Ohio); H. G. Sprague, Texaco, Inc.; H. D. Terrell, Gulf Research and Development Co.; R. C. Vollmar, Standard Oil Company of California; R. C. Wilbur, Shell Oil Co.

[2] ASTM Method of Test for Tetraethyllead in Gasoline, 1958 Book of ASTM Standards, Part 7, p. 267.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 53, p. 379 (1953); also Directory of ASTM Committee D-2 on Petroleum Products and Lubricants, Jan., 1960, p. 47.

TABLE I.—TEST DATA BY ASTM METHOD D 526 AND GOST-63.

TETRAETHYLLEAD, ML PER U S GAL.

Laboratory	Sample 60-1						Sample 60-2						Sample 60-3					
	ASTM Method D 526			GOST-63			ASTM Method D 526			GOST-63			ASTM Method D 526			GOST-63		
	1	2	Average	1	2	Average	1	2	Average	1	2	Average	1	2	Average	1	2	Average
No. 1	1.13	1.11	1.12	1.09	1.12	1.105	1.51	1.53	1.52	1.50	1.52	1.51	2.19	2.17	2.18	2.23	2.26	2.245
No. 2	1.14	1.16	1.15	1.08	1.15	1.115	1.50	1.45	1.475	1.57	1.56	1.565	2.19	2.20	2.195	2.08	2.16	2.12
No. 3	1.16	1.15	1.155	1.04	1.06	1.05	1.49	1.50	1.495	1.55	1.55	1.55	2.15	2.15	2.15	1.95	1.98	1.965
No. 4	1.18	1.19	1.185	0.98	1.01	0.995	1.54	1.53	1.535	1.52	1.44	1.48	2.20	2.22	2.21	1.94	2.02	1.98
No. 5	1.13	1.15	1.14	0.89	0.80	0.845	1.45	1.47	1.46	1.51	1.55	1.53	2.19	2.26	2.225	1.75	1.67	1.71
No. 6	1.11	1.12	1.115	0.85	1.10	0.975	1.44	1.46	1.45	1.50	1.49	1.495	2.12	2.14	2.13	2.04	2.05	2.045
No. 7	1.17	1.17	1.17	1.23	1.21	1.22	1.57	1.55	1.56	1.60	1.62	1.61	2.25	2.24	2.245	2.26	2.26	2.26
No. 8	1.20	1.17	1.185	0.77	0.72	0.745	1.28	1.35	1.315	1.34	1.43	1.385	2.21	2.33	2.27	1.48	1.63	1.555
No. 9	1.09	1.14	1.115	1.29	1.29	1.29	1.53	1.50	1.515	1.48	1.53	1.505	2.17	2.21	2.19	1.60	1.60	1.60
No. 10	1.17	1.18	1.175	0.94	0.92	0.93	1.54	1.54	1.54	1.25	1.23	1.24	2.22	2.21	2.215	1.44	1.68	1.56
No. 11	...	...	...	0.99	1.02	1.005	...	...	...	1.59	1.56	1.575	...	...	...	2.02	1.99	2.005
No. 12	1.18	1.17	1.175	1.10	1.10	1.10	1.53	1.53	1.53	1.53	1.53	1.53	2.21	2.20	2.205	2.11	2.09	2.10
No. 13	1.18	1.19	1.185	1.08	1..	1.075	1.51	1.57	1.54	1.52	1.52	1.52	2.26	2.22	2.24	1.99	1.96	1.975
Total			13.870			13.450			17.935			19.495			26.455			25.120
Grand averages			1.156			1.035			1.494			1.500			2.204			1.932

Laboratory	Sample 60-4						Sample 60-5					
	ASTM Method D 526			GOST-63			ASTM Method D 526			GOST-63		
	1	2	Average	1	2	Average	1	2	Average	1	2	Average
No. 1	3.23	3.23	3.23	3.26	3.26	3.26	4.40	4.40	4.40	4.41	4.42	4.415
No. 2	3.07	3.14	3.105	3.29	3.22	3.255	4.31	4.39	4.35	4.00	4.02	4.01
No. 3	3.26	3.25	3.255	3.30	3.28	3.29	4.36	4.27	4.315	4.15	4.21	4.18
No. 4	3.27	3.29	3.28	3.33	3.34	3.335	4.44	4.42	4.43	3.94	4.06	4.00
No. 5	3.25	3.28	3.265	3.27	3.30	3.285	4.39	4.40	4.395	3.60	3.82	3.71
No. 6	3.12	3.17	3.145	3.14	3.13	3.135	4.33	4.29	4.31	3.29	3.35	3.32
No. 7	3.24	3.26	3.25	3.26	3.26	3.26	4.37	4.37	4.37	4.36	4.36	4.36
No. 8	3.26	3.20	3.23	2.94	2.96	2.95	4.40	4.36	4.38	3.72	3.49	3.605
No. 9	3.16	3.10	3.13	3.18	3.18	3.18	4.45	4.44	4.445	3.27	3.11	3.19
No. 10	3.26	3.26	3.26	3.06	3.11	3.085	4.41	4.40	4.405	3.47	3.55	3.51
No. 11	...	...	...	3.27	3.28	3.275	...	...	...	3.66	3.65	3.655
No. 12	3.27	3.29	3.28	3.29	3.28	3.285	4.42	4.43	4.425	4.15	4.13	4.14
No. 13	3.23	3.23	3.23	3.21	3.22	3.215	4.45	4.40	4.425	4.21	4.32	4.265
Total			38.660			41.810			52.650			50.360
Grand averages			3.222			3.216			4.388			3.874

TABLE II.—SUMMARY OF COMMENTS ON ANALYTICAL TIME AND PREFERRED PROCEDURE.

ANALYTICAL TIME, HR

Laboratory	ASTM Method D 526	GOST-63	Preference
No. 1	7.5 per 5 samples[a]	7 per 5 samples	D 526-oxidation, GOST-63-volumetric finish
No. 2	18[b]	24[b]	...
No. 3	6 to 8 samples per day	12 samples per day	GOST-63
No. 4	8[b]	11[b]	GOST-63-titration, Method D 526-oxidation
No. 5	8	12	...
No. 6	1,[b] 7.75[c]	1.25,[b] 3.25[c]	GOST-63-finish, Method D 526-extraction
No. 7	6[c]	2[c]	GOST-63
No. 8	10 for entire program[b]	15 for entire program[b]	Method D 526
No. 9	8[b]	12[b]	Method D 526
No. 10	3.5 days for 10 samples	4 days for 10 samples	Method D 526
No. 11	...	150 min for 1,[c] 117 min for 1[b]	...
No. 12	7[c]	2[c]	Method D 526
No. 13	As GOST plus several hours	4.5[c], 3.5[b]	Method D 526

[a] Plus overnight standing.
[b] Working time.
[c] Elapsed time.

TABLE III.—DATA BY OTHER PROCEDURES.

	Sample 60-1	Sample 60-2	Sample 60-3	Sample 60-4	Sample 60-5
Tetraethyllead, ml per U S gal, added	1.15	1.55	2.25	3.25	4.35
Tetraethyllead, ml per U S gal, grand average ASTM Method D 526	1.16	1.49	2.20	3.22	4.39
Laboratory	TETRAETHYLLEAD CONTENT FOUND, ml per U S gal				
No. 2[a]	1.11, 1.11	1.42, 1.44	2.05, 2.03	3.01, 2.99	4.07, 4.15
No. 3[b]	1.13	1.45, 1.46	2.30	3.20	4.56
No. 5[b]	1.21	1.53	2.18	3.35	4.36
No. 6[b]	1.13, 1.13	1.51, 1.52	2.25, 2.25	3.11, 3.12	4.36, 4.36
No. 7[b]	1.31	1.58	2.30	3.22	4.60
No. 8[a]	1.18	1.51	2.23	3.23	4.46
No. 9[b]	1.12	1.47	2.12	3.04	4.30
No. 12[c]	1.18, 1.19	1.55, 1.55	2.20, 2.20	3.29, 3.30	4.43, 4.45

[a] Polarograph. [b] X-ray. [c] Versenate.

TABLE IV.—SUMMARY OF OTHER COMMENTS.

Laboratory		Comments
1, 4, 6, 8, 9, 10	1.	The ASTM oxidation procedure is preferred because there are fewer manipulations.
1, 3, 4, 6	2.	The GOST-63 volumetric finish is faster.
3	3.	GOST-63 is 2 to 3 times faster than D 526.
7	4.	GOST-63 is less tedious and time consuming.
13	5.	GOST-63 filtration step is too slow.
3	6.	Samples 60-1, 60-3, 60-5 did not seem representative of normal gasoline—difficult to analyze by both methods.
3	7.	GOST-63 results on samples 60-1, 60-3, 60-5 believed low because red material that formed during HCl treatment prevented complete dissolving of $PbCrO_4$.
3	8.	GOST-63 makes no provision for corrected results to a fixed reference.
3	9.	In GOST-63, conversion from grams per kg should be 0.606 instead of 1.213.
3	10.	In GOST-63, in order to dissolve the $PbCrO_4$ should the solvent be poured through filter paper containing the lead or should the filter paper be put in a beaker?
4, 5	11.	GOST-63 modified by adding 5 ml of concentrated HCl to HCl-NaCl solution of the $PbCrO_4$ to prevent precipitation of PbI_2.
4, 9	12.	In GOST-63, Paragraph II-2 difficult to interpret.
4, 9	12a.	Interpreted to mean—boil $PbCrO_4$ for 10 min, cool for 10 min, and filter while hot.
8, 10	12b.	Interpreted to mean—boil for 10 min and cool to room temperature followed by an additional 10 min standing period.
4, 5, 8, 9, 10	13.	Using GOST-63, the HCl extracts of samples 60-1, 60-3, 60-5 were dark colored and contained appreciable suspended matter. Extracts of samples 60-2 and 60-4 were water white.
4, 6, 9, 10	14.	Using GOST-63, the $PbCrO_4$ obtained from samples 60-1, 60-3, 60-5 was discolored.
4	15.	Using GOST-63, sample 60-5 was filtered before precipitating the $PbCrO_4$.
6, 8, 9, 10	16.	GOST-63 does not eliminate organic matter carried over with HCl extracts.
12, 13	17.	Wet oxidation desirable in GOST-63, especially on cracked gasolines. Lower results on these samples may be due to presence of organic matter or incomplete extraction.
11	17a.	The soluble hydrocarbons may have interfered in precipitation step and perhaps occluded some $PbCrO_4$.
8	18.	Lower results by GOST-63 due to smaller amount of acid used in extraction step.
6	19.	Cannot account for low results on sample 60-5 by GOST-63. Got 3.80 at a later date.
7	20.	Used 50-ml samples.
8, 9, 10, 13	21.	In GOST-63, transfer of extracts is conductive to losses of material and is time consuming. Method D 526 is less subject to error.
12	22.	Both methods require refluxing for same time, but ASTM Method does not require transferring.
13	23.	Not much difference in operator time, but elapsed time for Method D 526 is several hours longer because of digestion of precipitate.
9	24.	In GOST-63, Paragraph III-4—A 100-ml buret was used.
10	24a.	A 100-ml cylinder was used.
9, 10	25.	In GOST-63, Paragraph III-5—After refluxing with concentrated HCl, there followed one refluxing with 1:4 HCl and one with distilled water.
10	25a.	Then reflux condenser, flask, and separatory funnel washed in this sequence with 25 ml of water. All washings went through the gasoline in the separatory funnel. It could be interpreted that washes should be added directly to the extract.
10	26.	In GOST-63, the acetic acid solutions of cracked gasolines were filtered because the method states that precipitation is to be done from a clear solution.
10	27.	In GOST-63, neutralization with NH_4OH and acidification did not clear-up solutions from catalytically cracked gasolines.
10	28.	Titration of chromate to get titre on thiosulfate was performed immediately after dissolving the lead chromate. In the case of the samples, all titrations were done together. This required about a four-day waiting period.

TABLE V.—PRECISION OF ASTM METHOD D 526 AND GOST-63.

Sample	Tetraethyllead, Content Found, ml per U S gal Grand Average		Actual Tetraethyllead Added, ml per U S gal	Repeatability, Tetraethyllead, ml per U S gal			Reproducibility, Tetraethyllead, ml per U S gal		
	Method D 526	GOST-63		Method D 526		GOST-63	Method D 526		GOST-63
				Method D 526	This survey		Method D 526	This survey	
60-1	1.156	1.035	1.15	0.055	0.045	0.172	0.091	0.086	0.448
60-2	1.494	1.500	1.55	0.063	0.074	0.087	0.100	0.206[a]	0.292
60-3	2.204	1.932	2.25	0.078	0.098	0.192	0.119	0.123	0.761
60-4	3.222	3.216	3.25	0.101	0.082	0.059	0.147	0.188	0.325
60-5	4.388	3.874	4.35	0.121	0.091	0.245	0.178	0.137	1.238

[a] 0.127 without laboratory No. 8.

No. 250 December 1960

Nineteen-Sixteen
Race Street
Philadelphia 3, Pa.

ASTM Bulletin

Bulletin To Be Monthly; Adopt New Name, Cover, Format

STARTING WITH the next issue, January, 1961, the ASTM BULLETIN will be published monthly, and under a new name, *Materials Research & Standards*. At the same time, changes will be made in the cover design, in typography, and in the arrangement of material in the magazine. All these changes are being made after careful study and with only one end in view: better service to our readers.

The new name reflects the fact that the magazine is no longer purely a news bulletin of ASTM activities—nearly half the contents are papers and articles in the area of research and standards for materials.

With 12 instead of 8 issues per year, the contents of the magazine will be more timely. News of Society activities and information about the ceaseless work of the technical committees and the resulting unending stream of continually changing standards will be published with less delay. It is hoped that the ever-growing number of technical papers that are accepted by the Society for publication will see the light of day with greater dispatch.

The increased frequency of publication will mean, of course, increased subscription rates. Effective Jan. 1, 1961, the rates will be:

Number of Years	U. S.	Canada	Foreign
1	$ 5.00	$ 5.75	$ 6.50
2	8.50	10.00	11.50
3	12.00	14.25	16.50

Changes in format are aimed toward making it easier for the reader to find what he wants. Beginning in January, the magazine will comprise three major sections: technical papers, feature articles, and Society news, which will appear in each issue in that order. *Materials Research & Standards* will continue to serve a dual function as a medium for papers and articles of broad interest in the field of research and standards for materials and as a bulletin of Society news.

Typography will be changed (chiefly in the various department heads), not merely for the sake of change, but rather for easier reading and scanning, and to minimize clutter and give a sense of unity to the magazine.

A survey conducted within the past year, during which we heard from more than 550 of our readers, has been most helpful in our planning for these changes. We were most gratified to find that many gave careful thought to our questions and came up with very worthwhile suggestions. We herewith express our gratitude to them, and we invite all of our readers at all times to tell us their desires. A Society-sponsored publication should reflect the wishes of the members.

A.Q.M.

Errata in "*Fracture Testing of High-Strength Sheet Materials*"

An article on "Fracture Testing of High-Strength Sheet Materials," which consisted of a report of a special ASTM committee, appeared in two parts in the January and February, 1960, issues of the ASTM BULLETIN. Reprints of the complete article have also been distributed.

Since publication, two errors have been noted in the description of the symbols used in Table II (January issue, p. 35). P is expressed in decimal values; therefore the description of the symbol P should be:

$$P = \frac{\text{Per cent shear}}{100}$$

Also, the description of the symbol B should be:

B = Specimen thickness.

MATERIAL QUESTIONS

NEARLY EVERY day the mail at ASTM Headquarters includes some questions about materials, specifications, test methods, or related problems. We feel that the answers, many of which are based on information given us by officers of committees in their capacity as committee officers, are of general interest. For the most part, inquiries we receive are related to the activities of the Society, either standards, research work, or publication. Often, an inquiry is such that the services of a consultant or independent testing or research laboratory is obviously required; in this event we do not hesitate to so recommend.

Viscosity by Falling Ball

Originally, Method D 871 – 48 described the determination of viscosity by the falling-ball method. Later, Method D 1343 – 54 T was written specifically to describe viscosity determination by the falling-ball method as a general technique applicable to various cellulose derivatives. Method D 871 – 56 does not now cover a viscosity method, making reference only to D 1343 – 56. However, somewhere along the line the $\frac{5}{16}$-in. steel ball specified in Method D 871 – 48 was not included in Method D 1343 – 56. Why was this size deleted?

● Two industrial laboratories independently worked out methods for determining viscosities in bottles using the ball-drop method. Results of some of this work were published in a paper in *Analytical Chemistry*, Vol. 22, p. 656, May, 1950. This paper provides a background for the thinking that led to the eventual adoption of this procedure by Committee D 23. The ball-drop distance of 2.25 in. was originally specified for the bottle method. This distance was later changed to 2.00 ± 0.02 in., as specified in Method D 1343. By calculation and actual testing it was found that if the distance is 2 in., then, for a given solution, the number of seconds viscosity is the same when using the following two sets of conditions:

	Specified in Methods D 871 - 48 and D 301 - 50	Specified in Method D 1343
Type ball	Steel	Stainless steel
Ball diameter, in.	$\frac{5}{16}$	$\frac{3}{32}$
Ball density, g per cu cm	7.76	7.68
Ball drop distance, in.	10	2
Tube or bottle diameter, in.	1	2½

This interchangeability is referred to in footnote 4 of Method D 1343, which reads: "When, however, a $\frac{3}{32}$-in. stainless steel ball is used, the viscosities in seconds should be practically the same as those obtained using the apparatus described in Section 11 of Method D 871 – 48, and in Section 10 of Specification D 301 – 50."

MATERIAL QUESTIONS

Glass Filtering Disks

What is the minimum pressure at which gas flow starts in glass filtering funnels having fritted glass filtering disks of (1) very fine pore size (2.5 μ max), and coarse pore size (60 μ max), for funnels ranging in capacity from 15 to 600 ml?

● This pressure depends upon the effective diameter of the largest pore in a given filter and must be determined experimentally for that filter, because only in this way can the effective diameter of the largest pore be known. However, if one wishes to know what the pressure would be for a filter in which the largest effective pore has a certain *assumed* diameter, then the pressure for such a filter can be calculated from the equation

$$D = \frac{30\,\gamma}{p}$$

where:

D = maximum pore diameter, microns,
γ = surface tension of the test liquid in dynes per centimeter at the temperature of the test, and
p = pressure in millimeters of mercury.

The pressure so calculated would be in millimeters of mercury. This procedure is independent of the capacity of the filter or the diameter of the disk.

1961 Nominating Committee

IN ACCORDANCE with the By-laws of the Society, which provide that the Board of Directors shall select a nominating committee for officers, the Board has appointed the members shown below to the 1961 Nominating Committee. Serving *ex officio* are the three immediate past-presidents: R. T. Kropf, K. B. Woods, and F. L. LaQue. The committee will meet in February and will nominate for the offices of president, vice-president, and directors. Their selections will be announced in the ASTM BULLETIN before the official ballots are transmitted.

MEMBERS	ALTERNATES
J. R. LeCron, Bethlehem Steel Co.	P. R. Wray, U. S. Steel Corp.
F. W. Reinhart, National Bureau of Standards	Robert Burns, National Research Council
Harold Smith, U. S. Bureau of Mines	J. B. Rather, Jr., Socony Mobil Oil Co.
R. R. Litehiser, Ohio State Highway Dept.	W. J. McCoy, Lehigh Portland Cement Co.
R. B. Saltonstall, Udylite Corp.	A. W. Tracy, Anaconda American Brass Co.
E. C. Shuman, Owens-Corning Fiberglas Corp.	J. H. Koenig, Rutgers University

Schedule of ASTM Meetings

This gives the lastest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Jan. 16–17	Committee A-6 on Magnetic Properties	Pittsburgh, Pa.
Jan. 16–18	Committee B-5 on Copper and Copper Alloys, Cast and Wrought	New York, N. Y.
Jan. 19	Pittsburgh District (Joint with Soc. for Nondestructive Testing)	Pittsburgh, Pa.
Jan. 19	Philadelphia District (Joint with Am. Soc. for Quality Control)	Philadelphia, Pa.
Jan. 19	Southern California District	Los Angeles, Calif.
Jan. 23	Northern California District	San Francisco, Calif.
Jan. 23–24	Committee B-1 on Wires for Electrical Conductors	Philadelphia, Pa. (Society Headquarters)
Jan. 23–25	Committee A-1 on Steel	Pittsburgh, Pa. (Penn-Sheraton)
Jan. 25	Northwest District	Seattle, Wash.
Jan. 25–27	Committee D-19 on Industrial Water	Pittsburgh, Pa. (Penn-Sheraton)
Jan. 30–Feb. 3	Committee Week	Cincinnati, Ohio (Netherland-Hilton)
Feb. 3	Washington District	Baltimore, Md
Feb. 5–10	Committee D-2 on Petroleum Products and Lubricants	Philadelphia, Pa. (Benj. Franklin)
Feb. 6	Committee E-19 on Gas Chromatography	Philadelphia, Pa. (Society Headquarters)
Feb. 6–8	Committee D-1 on Paint, Varnish, Lacquer and Related Products	Roanoke, Va. (Hotel Roanoke)
Feb. 6–9	Joint ASTM-TAPPI Committee on Petroleum Wax	Philadelphia, Pa. (Benj. Franklin)
Feb. 8–10	Committee D-16 on Industrial Aromatic Hydrocarbons and Related Materials	Philadelphia, Pa. (Benj. Franklin)
Feb. 23–24	Committee D-6 on Paper and Paper Products	New York, N. Y. (ASA Headquarters)
Feb. 24	Committee D-25 on Casein and Similar Protein Materials	New York, N. Y. (Borden Co.)
Feb. 27	Committee E-13 on Absorption Spectroscopy	Pittsburgh, Pa. (Penn-Sheraton)
Feb. 27–28	Committee B-9 on Metal Powders and Metal Powder Products	St. Louis, Mo.
Feb. 28–March 3	Committee D-13 on Textile Materials	New York, N. Y. (Sheraton-Atlantic)
March 2	Committee E-2 on Emission Spectroscopy	Pittsburgh, Pa. (Penn-Sheraton)
March 6	Central New York District (Joint with Am. Soc. for Metals)	Utica, N. Y.
March 6–8	Committee D-9 on Electrical Insulating Materials	Louisville, Ky. (Sheraton Hotel)
March 7	Southeast District	Birmingham, Ala.
March 7–8	Committee F-2 on Flexible Barrier Materials	East Lansing, Mich. (Michigan State University)
March 7–10	Committee D-20 on Plastics	Louisville, Ky. (Sheraton Hotel)
March 8	Southwest District	New Orleans, La.
March 9	Southwest District	Houston, Tex.
March 10	Southwest District	Dallas, Tex.
March 11	Southwest District (Joint with Am. Chemical Soc.)	Bartlesville, Okla.
March 13	Washington District (Joint with Raleigh Engineers' Soc.)	Raleigh, N. C.
March 23–24	Committee D-14 on Adhesives	Washington, D. C.

District Activities

CENTRAL NEW YORK

Ceramics for Electronics Still Largely Untilled Field

RESEARCH ON the electronic applications of metallic oxides is the most exciting area in the ceramic field today, according to P. V. Leffel, manager, Ceramic Dept., Electrical Products Div., Corning Glass Works, who spoke at a joint meeting of the Southern Tier Chapter of the American Society for Metals and the ASTM Central New York District, Oct. 10, 1960, at Corning, N. Y. Current problems, present applications, and future expectations in this field were presented by Mr. Leffel jointly with Fred Bickford, manager of technical research, Ceramic Research Div., and Donald Forbes, chief development engineer, Ceramic Dept.

These materials have good high-frequency electrical properties and are used in such components as electron tubes, transistorized and miniaturized electronic assemblies, and piezoelectric primers for detonating devices. Physical properties of ceramics also recommend them for such uses as missile leading edges and for atomic applications in fuel elements, moderators, and safety devices. The electronic applications of these materials were entirely unsuspected 25 years ago, and many feel that only a small portion of their ultimate possibilities have so far been explored. For example, beryllia (BeO) is both an electrical insulator and a thermal conductor—what are the ultimate possibilities of such a combination of properties? Beryllium oxide is also being rapidly developed because of its unusual thermal, electrical, mechanical, and nuclear properties.

High-alumina bodies (on the order of 85 to 100 per cent Al_2O_3) are extremely rewarding materials—strong, very hard and refractory, excellent electrical properties, dimensionally stable, chemically inert. The compositions that approach 100 per cent alumina have not yet been successfully metallized to permit vacuum-tight high-temperature assemblies. The properties of these aluminas are not only a function of composition but also of preparation and firing treatment. Much remains to be explored in this field.

Strength and thermal shock resistance are areas that also need much attention. No satisfactory standard test has as yet been developed to measure tensile strength of ceramic materials.

A need of high priority is for increased ductility. Recent research indicates that potassium bromide and magnesia single crystals can be made ductile at room temperature. Ductile polycrystalline ceramic materials may lie just over the horizon.

One of the most pressing problems in this industry is how to make production ceramics that are as good as the best from the laboratory. Other pressing production problems are supplying ceramic materials to the same order of tolerances as other materials, better means to control shrinkage, improved methods of forming, better fabrication techniques for ceramic-to-metal seals, and precision grinding of the finished pieces. The ceramist is also interested in reducing the number of crystals in ceramic material for electronic applications to a minimum so as to permit improved control of density and other physical properties.

The possibilities of continued fruitful research in this field have been prompting more and more ceramics organizations to initiate research in this growing field of materials science.

MISSISSIPPI VALLEY

Seniff Scolds U. S. Motorist

"ENGINES ARE the key to abundance." So said Wade Seniff, vice-president of ASTM, and manager of research, Baltimore & Ohio Railroad Co., speaking before a joint meeting of the Mississippi Valley District of ASTM and the Engineers Club of St. Louis, October 27. "In the United States we have 7 per cent of the world's population, but we convert 35 per cent of the total energy into useful work each year. This disproportion is something to wonder about rather than brag about. The reason for this tremendous advantage can be summed up in one word, 'engines.'"

With this as a starting point, Mr. Seniff went on to trace the development of engines both in America and abroad, detailing the advantages secured with each step forward.

Turning to one of the most common uses of the engine—the American car—Mr. Seniff had this to say: "You can take thousands of miles of service out of an engine in a few minutes of racing it at idle to warm it up. You can cut its life by a third with poor ignition or poor carburetion. City stop-and-go driving wears out and sludges up an engine much faster than cross-country driving. It is the very small things that count if you want an engine to operate a long time. You can have poor ignition in both gasoline and diesel engines, which the average driver would never recognize as a malfunction.

"Periodic tune-up by a qualified tune-up mechanic is a good investment. Always check the oil every time you get gasoline, and if you are interested in your engine's life look at the dip stick yourself. Wipe it on a piece of window cleaning tissue or a cloth and look for cleanliness. Soot or signs of water are danger signs. One should never see moisture, granular sludge, or rust on a dip stick—if you do your engine is in trouble. I consider air filters more important than oil filters, but you generally have to make a special request to get your filling station or garage man to give attention to either. There are more miles in any engine than the average person believes, and he can have them if he wants them badly enough to

AT MISSISSIPPI VALLEY DISTRICT

(Left to right) ASTM Vice-President R. W. Seniff; H. O. Croft, dean of engineering, University of Missouri; A. M. Siegel, chairman, Mississippi Valley District; Don Fischer, dean of engineering, Washington University; V. J. Blum, S.J., dean, Institute of Technology, St. Louis University; and C. L. Wilson, dean, Missouri School of Mines.

pay attention to these little things.

"The average car owner does not know what it actually costs him; there is something about the possession and operation of a large motor car which provides an effective anesthesia for any awareness of economy. The average driver likes to ride alone in about two tons of steel behind as many horsepower—which he cannot use—as he can get. He insists on power-consuming luxury gadgets, accelerates too rapidly, drives too fast, and consumes about 10 per cent of the total energy produced in the United States, which is about equivalent to the energy consumed by all manufacturing processes."

Prior to Mr. Seniff's address, the Mississippi Valley District presented its Student Membership Prize Awards to students from St. Louis University, Washington University, Missouri School of Mines, and the University of Missouri. It was most gratifying to the District Council to have present for the ceremonies the deans of the respective schools of engineering (see cut).

The meeting was held at the newly constructed Engineers Club in St. Louis with Mr. A. M. Siegel, chairman of the district, presiding.

NEW YORK

New Hope Seen for Man in Contest with Machine

Is THERE a computer in your future? There may well be. Extremists predict that computers will one day take over middle management. "Don't you believe it," said Milton N. Stone, speaking before a joint meeting of the ASTM New York District and the Chemists Club in New York on October 27. Mr. Stone, who heads up Arthur D. Little's activities in data processing, information handling, and management information systems, told a capacity group at the Chemists Club what they can expect from computers of the future, particularly in engineering and science. A computer, he said, is one of several elements in an information or data processing system, which comprises: sensing elements (pressure gage, thermometer, counter, etc.); data converters; transmission links; computers (these manipulate the information); storage devices; display devices (automatic printers, TV screens, etc.); and effectors (a motor-operated rack and pinion, a solenoid, etc.)

Then there are the various types of process control systems, which include sorters for size, length, etc.; positioning systems; sequence controllers; and optimizing systems. In optimizing, a computer might be used to evaluate a research program and highlight the areas where efforts are likely to be most fruitful, or to choose the best of a number of formulations or designs.

There are many misconceptions about computers, such as "computers will cut costs." This never happens, since at least as many people are needed for supporting the computer operations and maintenance as were used before. Then there is the matter of the computer turning out information faster. It does, but how does one cope with this greater volume of information effectively? Mr. Stone said, somewhat facetiously, that the reaction time for a typical corporation is about one-fourth year, and this being the case, of what value is a rapid flow of great masses of information? Also, there is the misconception that computer information is clean, or error-free. This is true only if the information put into the computer is error-free.

Mr. Stone advised any company seeking to determine whether or not it can use a computer to advantage in information processing to consider the computing art as equivalent to any other branch of technology requiring considerable textbook knowledge, as well as practical use experience. For example, a company with an interest in applying computers might send several of its top management people to computer programming school, not so that they could learn to do the programming on a computer but so that, through a practical grasp of the technology of computers, they would be in a position to generate ideas.

Finally, Mr. Stone cited the well-known natural laws, first enunciated by Murphy, which computers are unusually prone to obey: (1) if something can go wrong, it will; (2) things always go from bad to worse; and (3) Nature always sides with the hidden flaw.

PHILADELPHIA

Massive Housing Program Dominates Soviet Scene

ANY THOUGHT THAT the Soviet Union is concentrating its efforts only on military hardware was dispelled by a slide-illustrated lecture given by A. Allan Bates, president of ASTM, and vice-president of research and development, Portland Cement Assn. His talk was based on a recent trip through the Soviet Union as leader of a team of scientists and engineers in the construction field. The trip was sponsored by the National Academy of Sciences as part of an information exchange agreement between the United States and the USSR. Speaking before a meeting of the Philadelphia District held on the campus of the University of Delaware at Newark, Del., Nov. 9, Dr. Bates emphasized the need for Americans to realize that the Soviets were working hard to industrialize their country, and as part of this program they have undertaken a massive construction program. Using "housing factories," they are prefabricating not only concrete wall panels but even entire apartment units, which, when stacked much like children's play blocks, form utilitarian if not attractive dwellings. Recreational facilities are going up side-by-side with these apartments even in remote Siberian areas.

According to Dr. Bates, construction is the dominant industry in the Soviet Union; more effort is going into this industry than into any other single endeavor.

Prior to Dr. Bates' talk, presentation of Philadelphia District Student Prize Awards were made.

Presiding at the meeting was H. W. Stuart, chairman of the Philadelphia District Council. T. A. Marshall, Jr., newly appointed ASTM executive secretary, was introduced, as was the dean of engineering for the University of Delaware, Prof. E. W. Comings.

NEW ENGLAND

Automation Seen as Stimulus for New England Industry

"AUTOMATION IS, potentially, the deciding factor in the economic survival and industrial stimulation of New England. The great challenge facing American industry—and particularly industry in New England—is to initiate programs of modernization and automation." E. F. Walsh, manager of steam generation for the New England Electric System, issued this warning in his opening remarks as chairman of an automation symposium held at the New England District meeting, at the Boston Museum of Science, October 27.

"New England industry must face the fact that automation is inevitable if we are not to be left behind in today's technological race," Mr. Walsh continued. He pointed out that it is no longer a question of whether or not to automate, but rather it is how far to go and how fast to proceed. "The threat of foreign competition and the basic economic character of the cold war has tied automation to our well-being and survival."

Speaking on "The Inevitability of Automation," R. C. Mix, coordinator of automation development operation, General Electric Co., outlined the problems that arise in converting a plant to automatic operation. The first of these is a lack of knowledge of the production and management processes. To overcome this, management will have to "re-think" many of its processes, making them less "art" and more "science." The second problem stems from the fact

that technical ability to automate exceeds ability to prove economic feasibility. Management must be able to recognize opportunities and be willing to venture its resources to broaden applications where there is experience with automation. The third problem is that personnel will require retraining for new operating methods and techniques. Fourth, is the problem of psychological resistance. "A surprising number of people habitually resist change and seem to be afraid of anything new," according to Mr. Mix. To live in the kind of future we hope to live in, we need change; and we need the knowledge, the entrepreneurial courage, and the ingenuity that change requires.

N. E. Hiatt, of the metal rolling processing and sales operation of the General Electric Co., described many of the applications of automation to different types of steel plants. Progress in this area in the last four or five years, he said, has been extremely rapid.

Automatic program controls and automatic material handling systems were described by R. E. Pfeif and P. L. Russell, respectively.

L. F. Kennedy pointed out that the major motivation toward automation in the utilities comes from considerations of safety of equipment and reliability of service. "As the utility systems have grown," said Mr. Kennedy, "there has been a resulting increase in complexity to the point where the ability of the human operator to absorb all necessary information, analyze it correctly, and then act promptly is open to serious question. . . . As one writer has pointed out, the amount of data required to operate one of today's high-pressure, high-temperature, high-capacity boiler-turbine-generator units is over 100 times that required for the smaller, simpler units of over 20 years ago. Such a task becomes impossible except through the phenomenal ability of the preprogrammed digital computer to absorb data and always act in accordance with preplanned programs."

Some 175 ASTM members and guests attended the afternoon program and stayed for the social hour and dinner in the evening. Carl G. Johnson, vice-president of the New England District Council and chairman of its Student Membership Prize Award Program announced the names of 24 students to receive the awards.

Bates Views Future Task for U. S. Construction Industry

Speaking on materials for the future, ASTM President A. Allan Bates stated that, in the current political debate, one major group maintains that expansion of our economy needs to be at least 5 per cent per year or more, and the other maintains it needs to be something less. However, for the purpose of his remarks, Dr. Bates said the exact magnitude was unimportant.

Considering that presently the American Gross National Product is about $500 billion and assuming that there is a 4 per cent increase through the 1960's, by 1970 the GNP will amount to about $750 billion; and in 1980 the figure will reach about $1100 billion. According to Dr. Bates, the bulk of engineering materials go into construction or adjuncts of construction; and in 1960 the construction industry will account for $70 billion, or 14 per cent of the total GNP. Assuming the same rate of 14 per cent in the 1970's and 1980's, the value of construction will be in the neighborhood of $105 billion and $150 billion, respectively. The question then arises; will we have the necessary engineering materials for such a construction activity? How shall we allocate them to various uses?

It has been stated by some planners, said Dr. Bates, that in the next 35 or 40 years the equivalent of practically all of America's present urban physical plant—buildings, factories, homes, streets, bridges, utilities—will have to be reproduced. The quantity of materials required for this will be immense. Dr. Bates cited the USSR as an example of what has been done in this type of rebuilding. In a period of little over a generation, homes for over 100 million people have had to be built. This seems to have been accomplished under extremely difficult circumstances.

The largest single physical activity in the Soviet Union today, said Dr. Bates, is construction. Not having skilled laborers, masons, carpenters, and others, in the same numbers as the United States, the Soviet Union has resorted to industrial methods and mechanized production. Large apartments and entire room units are being built of pre-cast concrete. Although there is much monotony in the resulting homes, they are a great improvement over what has been available in the past. The apartment groups being erected, while providing fewer rooms per family than the western European or American counterpart, are built around large green recreation areas. Dr. Bates concluded that, in the construction field, the USSR is doing a truly impressive job in view of the great difficulties inherent in the attempt to move from an agricultural to an industrial economy.

DISCUSSING AUTOMATION SYMPOSIUM AT NEW ENGLAND DISTRICT MEETING

(Left to right) F. J. Mardulier, Dewey & Almy Chemical Div., W. R. Grace & Co.; E. F. Walsh, New England Electric System; W. H. Meade, Boston Edison Co.; and R. C. Mix, General Electric Co.

ROCKY MOUNTAIN

Concrete Research Session Held at Tucson

CONCURRENT WITH a regional meeting of the American Concrete Inst., the ASTM Rocky Mountain District sponsored one session and cosponsored a second, on concrete research, Nov. 2, in Tucson, Ariz. Between the sessions, A. Allan Bates, president of ASTM, and a director of ACI, gave a luncheon talk outlining the roles of the two societies and contrasting their cooperative standardization efforts with those he found in the Soviet Union on his recent trip to that country.

Speaking to a standing-room-only audience, Dr. Bates stated: "Many years ago it was agreed that ACI would concentrate its efforts on design and construction procedures, while the ASTM would concentrate its efforts on materials. Both societies have worked along democratic principles taking note of the views from both producers and consumers. In contrast, in the Soviet Union, standardization might be said to run rampant. It starts with the government and goes down the line whether it be in materials, in design, or in construction procedures. It is all dictated from above by a super ASTM-ACI.

With John T. Young of the Arizona Aggregate Assn. presiding, the following papers were presented at the ASTM Research Session on Concrete:

Water Vapor Permeability of Concrete—D. F. Griffith, Naval Civil Engineering Laboratory, Port Hueneme, Calif.

Effect of Steam Curing on Important Concrete Properties—Elmo C. Higginson, Bureau of Reclamation, Denver, Colo.

Concrete Retempering Studies—M. J. Hawkins, Bureau of Reclamation, Ephrata, Wash.

Later in the day, Cedric Willson, vice-president of engineering, Texas Industries, Inc., Dallas, Tex., presided at a joint research session at which the following papers were presented:

Heat Resistant Concrete for Missile Bases—Herman G. Protze, Materials Technologist, Boston, Mass.

Abnormally Slow-Hardening Concrete—Lewis H. Tuthill, concrete engineer; Robert F. Adams, head of Concrete Laboratory; Shelly N. Bailey, engineer; and Ronald W. Smith, engineer, California Department of Water Resources, Sacramento, Calif.

Advances in the Use of Epoxy Resins with Concrete—J. D. Kriegh and T. C. Ewbank, University of Arizona.

Actions on Standards

(*Continued from p. 10*)

Standard Specification for:

Wrought Iron Plates (A 42–55)
Wrought Iron Rolled or Forged Blooms and Forgings (A 73–55)
Staybolt Wrought Iron, Solid (A 84–55)
Staybolt Wrought Iron, Hollow-Rolled (A 86–55)
Wrought Iron Rivets and Rivet Rounds (A 152–39)
Uncoated Wrought Iron Sheets (A 162–39)
Zinc-Coated (Galvanized) Wrought Iron Sheets (A 163–39)
Single and Double Refined Wrought Iorn Bars (A 189–42)
Rolled Wrought Iron Shapes and Bars (A 207–39)

Revised and Reverted to Tentative.—A certification clause has been added to each of the specifications. Section 3 on chemical composition of Specification A 162 was revised to make it conform to other wrought iron specifications. Additional revisions were made in Specification A 163 to bring it in accord with the referenced Specification A 90. Section 2 on manufacture of Specification A 189 was changed in line with revisions of Definitions A 81.

Corrosion of Iron and Steel

Tentative Specification for Zinc Coated (Galvanized) Steel Sheets of Structural Quality, Coils and Cut Lengths (A 446–60 T)

New Tentative.—The sheets coming under this specification are produced for use where the mechanical properties of the base metal are important. They are produced in five different grades with the tensile strength varying from 48,000 to 82,000 psi.

Coming District Meetings

District	Date	Place	Program
Pittsburgh	January 19	Pittsburgh	W. A. Black
	(Joint with Society of Nondestructive Testing)		
Philadelphia	January 19	Germantown	Joint with ASQC
Southern California	January 19	Los Angeles	A. Allan Bates
Northern California	January 23	San Francisco	A. Allan Bates
Northwest	January 25	Seattle (tentative)	A. Allan Bates
Washington	February 3	Baltimore	A. Allan Bates

Papers to Appear in Future Issues of the ASTM Bulletin

Use of Stormer Viscometer for Testing Rotogravure and Flexographic Inks and Use of a Modified McMichael Viscometer for Consistency of Printing Inks and Ink Vehicles—Ross Cummings, The California Ink Co.

Apparatus for Hardness Testing at Subatmospheric Temperatures—R. T. Begley and H. Kohute, Westinghouse Electric Corp., and L. France, Universal-Cyclops Steel Corp.

Intercrystalline Cracking and Creep-Rupture Life—H. H. Bleakney, Canadian Department of Mines and Technical Surveys

The Evaluation of Resistance Strain Gages at Elevated Temperatures—R. L. Bloss, National Bureau of Standards

Effects of Nuclear Radiation on Rubber—J. W. Born, The B. F. Goodrich Co.

Subsize Charpy Correlation with Standard Charpy—C. H. Curll, Watertown Arsenal Laboratories

A New Method for the Determination of Undissolved Water in Fuels—L. Gardner, National Research Council of Canada

Determination of the Mechanical Properties of Elemental Sulfur—J. M. Dale, Southwest Research Inst.

Fracture Characteristics of Notched Tensile Specimens of Titanium and a Titanium Alloy—G. W. Geil and N. L. Carwile, National Bureau of Standards

Evaluation of Micrometer and Microscopical Methods for Measuring Thickness of Floor Coverings—E. Horowitz, J. Mandel, R. J. Capott, and T. H. Boone, National Bureau of Standards

Stress Rupture Tests at 1350 F on Type 304 Stainless Steel—W. D. Jenkins, W. A. Willard, and W. J. Youden, National Bureau of Standards

Detection of Glycols in Crankcase Oils—C. B. Jordan, Coating and Chemical Laboratory, U. S. Army

Workability of Masonry Mortar—L. Kampf, Borough of Queens, N. Y.

Determination of Gypsum and Its Dehydration Products in Their Mixtures—H. G. McAdie and R. A. Kuntze, Ontario Research Foundation

Tensile Cryostat for the Temperature Range 4 to 300 Kelvin—R. M. McClintock and K. A. Warren, National Bureau of Standards

A Stainless Steel for Standard Weights—S. J. Rosenberg and T. P. Royston

The Analysis of Stress-Rupture Data with a Minimum Deviation Function—W. J. Stutzman and J. W. Faber, Westinghouse Electric Corp.

A Simple Stress-Corrosion-Cracking Test for Copper Alloys—D. H. Thompson, American Brass Co.

A Study of the Centrifuge Test for Determining the Cement Content of Fresh Concrete—S. Walker, D. L. Bloem, D. G. Gaynor, and J. R. Wilson, National Bureau of Standards

Improved Cryostat and Accessories for Tensile Testing at −423 F—J. F. Watson, and J. L. Christian, Convair-Astronautics.

Coal and Coke

Tentative Method of Test for Plastic Properties of Coal by the Gieseler Plastometer (D 1812–60 T)

New Tentative.—This method of test covers a semiquantitative procedure for determining the relative plastic behavior of coal when heated under prescribed conditions in the absence of air. The test may be used when studying coals and blends used in carbonization and in other situations where plastic properties are of practical importance.

Electrical Insulating Liquids

Tentative Method of Test for Dielectric Strength of Insulating Oil of Petroleum Origin (Using VDE Electrodes) (D 1816–60 T)

New Tentative.—The oil in high-voltage, oil-filled apparatus is subjected to electric stresses of various intensities and various degrees of uniformity because of the varied configurations of electrode spacings employed in these structures. For this reason, when making the dielectric

(*Continued on p. 56*)

Technical Committee Notes

Thermal Insulation Group Weighs Standards Classification Scheme

THE PHILOSOPHY of specifications has been given special study in Committee C-16 on Thermal Insulating Materials, the purpose being to provide specifications that will more adequately meet the needs of the consumer. At the committee meeting held Sept. 26–28 at the Hotel Marcy, Lake Placid, N. Y., a classification system was proposed by which a consumer may select an existing ASTM specification to meet his particular needs. This suggestion is being explored by a special task force.

Development of specifications for rigid reflective sheathing board, representing a new type of insulating material, will be undertaken by the Subcommittee on Reflective Insulation. A task force to determine the properties and test methods required was established under the chairmanship of Sam Loring, Denny Paper and Board Co. Need for test methods to evaluate the corrosive effect of metals on reflective insulation is under study. Test runs on determining the over-all coefficient of heat transmission across reflective insulation indicates that the standard test methods for bulk-type insulation are not satisfactory for reflective insulation.

Steps were taken to establish a standard permeance specimen of 0.001-in. thick Mylar. A round-robin test program will be undertaken using a standard specimen, which will be stored at the National Bureau of Standards, for regular permeance determinations by both wet and dry cup methods. A report on the results of four round-robin testing programs on water vapor transmission through various materials will appear in the ASTM BULLETIN. The results show the variability of the method (C 355) using both the water and desiccant methods. Progress toward agreement among laboratories is shown, but equipment and techniques need to be improved.

A proposed test for corrosion inhibitiveness of thermal insulating cement will be submitted to the Society for acceptance.

Seven test methods for insulating structural roof deck, five for structural properties and two for thermal properties, were accepted in the Subcommittee on Structural Thermal Insulation. New standardization projects in this subcommittee are for mineral fiber, insulating boards such as poured-in-place roof deck and roof insulation, and expanded and foamed plastic mineral materials.

Russell H. Heilman was awarded a scroll for his long service and contributions to the committee as a charter member.

Methods for Extractables to Be Developed

COMMITTEE F-2 ON Flexible Barrier Materials met in Washington, D. C., Sept. 16, with officials of the Food and Drug Administration in a joint effort to develop methods to determine extractible materials in flexible barrier materials. Committee F-2 later set up a new section on extraction methods. Existing methods for extractables in polyethylene, polypropylene, and regenerated cellulosic films will be reviewed at the next meeting of the committee in March. Those interested in this work should get in touch with J. Frank Peake, Film Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.

Gas transmission properties are measured variously in the industry by some ten different methods. These are being reviewed for consolidation and further study. Methods E 96 on water vapor transmission of sheet materials are being reviewed for modification in order to make them applicable to flexible barrier materials.

A three-year study to determine what tests can be used for specifying materials for flexible barriers is nearing completion. Results will serve as a long-range plan of action for the committee.

Durability and Weathering Tests for Sandwich Structures

SANDWICH PANELS are now widely used in the construction of both aircraft and buildings. Most of the office buildings erected recently in large cities are of curtain-wall construction and in most cases involve the use of sandwich panels. This being a new type of construction, there is great concern about the durability and weathering characteristics of such structures. There is no long period of use of this type of construction upon which to judge these characteristics. Committee C-19 on Structural Sandwich Constructions has been engaged in a series of exposure programs at ASTM test sites and is developing an accelerated laboratory aging test method. At its meeting at ASTM Headquarters on September 4 and 5, the committee announced that the fourth exposure program, known as "Delta," will begin in April, 1961.

The purpose of a proposed aging test method circulated to the Subcommittee on Permanence, Durability, and Simulated Service is to determine how sandwich panels withstand severe exposure conditions. A choice of two laboratory aging cycles is included. Both involve immersion in water at 120 ±5 F, followed by exposure to steam and water vapor or to hot water. After six cycles of exposure, the specimens are then subjected to the usual shear, compression, tension, flexure, and delamination tests.

Test methods for sandwich core materials are being considered for such properties as fluid flow, water migration, impact, and energy absorption. A number of minor changes were accepted in the Shear Test in Flatwise Plane of Sandwich Constructions (C 273–53), Tension Test in Flatwise Plane of Sandwich Constructions (C 297–55), Edgewise Compressive Strength of Flat Sandwich Constructions (C 364–57), and Flatwise Flexure Test of Sandwich Constructions (C 393–57 T). A proposed tentative method of test for measuring flexure-creep of sandwich constructions is being balloted in the Subcommittee on Mechanical Properties of Basic Sandwich Construction.

Sound Absorption Test Methods Under Development

Development of test methods for sound absorption and their correlation with the large-scale reverberation room method (C 423) occupied Committee C-20 on Acoustical Materials at its fall meeting held at ASTM Headquarters on October 6. The box method will be prepared as information only following a round-robin test program with three laboratories participating. Results so far have revealed some lack in satisfactory reproducibility. The horn-coupler method will be drafted after test data from three installations are studied. Work continues on im-

proving the procedure for the reverberation room method, with the main problem being one of correcting for the specimen. Area progress has been made in establishing correlation of the several test methods through research at the National Research Council of Canada. A method of test for suspended ceilings, which has been considered by the Acoustical Materials Assn., will be studied in the subcommittee, with three facilities available for testing purposes. The study of duct silencers is being continued.

Review of various fire test methods has continued in the Subcommittee on Flame Resistance, including the radiant panel, 8-ft tunnel, and the Ingberg tunnel methods. Results of burn-out tests conducted in Canada have been distributed to the subcommittee. The ASTM Fire Test Method (E 119) will be studied to establish its usefulness for suspended ceiling systems.

Paint application methods continue to receive the attention of the Subcommittee on Maintenance. A proposed recommended practice for roller application of paint was reviewed. It is now planned to consolidate this method with a brush and spray method in one standard.

Mechanical suspension systems remain the chief interest in the Subcommittee on Application. A very active task force is formulating requirements and test methods and establishing direct liaison with both Committees E-5 on Fire Tests of Materials and Construction and E-6 on Methods of Testing Building Constructions. The need for a glossary of terms was expressed not only for this area but for the entire field of acoustical materials. The advisability of establishing a permanent subcommittee on nomenclature will be studied. Task groups will be considered for the development of recommended practices on methods of application and on job conditions.

Odor Consultant To Head Sensory Evaluation Committee

The new Committee E-18 on Sensory Evaluation of Materials and Products, at its organization meeting on Oct. 12, elected Amos Turk chairman. Dr. Turk, odor consultant from Danbury, Conn., has been active in the Society in Committee D-22 on Methods of Atmospheric Sampling and Analysis. The committee elected as vice-chairman H. L. Stier, National Canners' Assn., and as secretary Mrs. Mavis B. Carroll, General Foods. The scope approved was as follows:

The promotion of knowledge, stimulation of research, and the development of principles and recommended practices for the sensory evaluation (including discrimination and preference) of materials and products. These aims shall be furthered by:

1. Cooperation with other committees of the Society and with other organizations.
2. Preparation of standard definitions and nomenclature.
3. Establishment of principles of psychophysical test methods.
4. Preparation of recommended practices for design and conduct of tests, collection of data, and analysis and interpretation of results.
5. Fostering study of relationships between sensory evaluations and physical and chemical measurements.
6. Dissemination of information by technical publications and symposia.

The committee also approved four subcommittees, on: definitions and nomenclature, principles of psychophysical test methods, preparation of recommended practices, and instrumental-sensory relationships.

New Test Being Developed for Package Cushioning Materials

At the meetings of Committee D-10 on Shipping Containers, at Fort Belvoir, Va., October 4 and 5, work proceeded on a new method to test materials having a high degree of compressibility and recovery in bulk, sheet, or molded forms, used for cushioning packaged articles. This work is a development of Method D 1372 covering such materials.

A recommended practice covering the dead-load storage life of corrugated and solid fiberboard boxes is being developed, based on research studies at the Forest Products Laboratory. It is expected that this practice will also list the critical variables to be considered when predicting safe storage life, and a bibliography of research in this field. A general stacking failure curve has been developed, which, with appropriate safety factors, can be used for a broad variety of corrugated containers.

Interlaboratory tests of five different incline impact test machines (Method D 880) showed that a series of 10 replicates of four standard packages all rated the damage in the same order even though the impact values were different between machines owing to great differences of rigidity of the backstops. This work will serve as a basis for further study of the incline impact apparatus.

Data are being collected concerning electronic apparatus in use to determine displacement of package cushioning materials when subject to shock. This information will provide an up-to-date picture of testing in this field and will be used as a basis for recommendations on the use of this type of apparatus in conjunction with Method D 1596.

Plans Set for Symposium on Electron Device Processing

Planning for the Symposium on Materials and Electron Device Processing, to be held April 5, 6, and 7 at the Benjamin Franklin Hotel in Philadelphia, was one of many activities of Committee F-1 on Materials for Electron Tubes and Semiconductor Devices at its meeting Nov. 3 and 4 at Skytop, Pa.

The recently reorganized cathodes subcommittee now is carrying on all its work under three subjects: Section A, Electrical Tests; Section B, Physical and Mechanical Tests; Section C, Physical Chemistry. The subcommittee has completed revisions of the standards covering tests for cathode sleeves and tubing (F 128), specification for cathode sleeves (F 239), recommended practice for cathode melt prove-in testing (F 238), and test for sublimation characteristics (F 278). The subcommittee is studying the purity and quality of cathode coating materials and additives as a first step toward specifying the characteristics needed for use in cathodes.

The wire subcommittee has completed action on a long-needed and very thorough method for measuring the diameter and thickness of fine wire and ribbon. In this connection, a question was raised concerning the terminology of wire and strip, as many so-called wires may not have a circular cross-section.

A Group of Committee D-10 Members at the Meeting at Fort Belvoir, Va.

Technical Committee Notes

A new specification for nickel-iron-cobalt sealing alloys will be the first to contain both English and metric dimensions in line with a recently established policy of the committee to use both systems. A task group is at work laying ground rules for use of the metric system with English equivalents.

Several relatively newer subcommittees now may be expected shortly to turn out standards in some volume. Projects of the semiconductor subcommittee include the drawing of silicon crystals, orientation of single crystals, methods for measuring contactless resistance, oxygen content, dislocations, and base boron level in silicon.

The Subcommittee on Control of Contaminants is working on methods for determination of adsorbed gases and ions on surfaces, methods for examination for highly pure solvents, and methods for measuring and identifying extremely fine particles of dust. The committee plans to sponsor a session at the Spring Meeting, covering the problems of processing and handling beryllium and beryllia ceramics. These materials have excellent properties but are toxic, and precautions must be taken in working with them.

Study Gloss of Ceramic Tile

DATA FROM an interlaboratory test study for determining the best geometry for measuring the specular gloss of glazed ceramic tile were presented at a September 29 meeting of Committee C-21 on Ceramic Whitewares and Related Products at Bedford Springs, Pa.

Thirty-three specimens of glazed ceramic tile ranging from high gloss to a mat finish were reviewed by six operators using four types of gloss measuring equipment. The committee feels that the industry has a greater interest in measuring degree of matness than degree of glossiness and is therefore proposing to standardize the method of test for determining the specular gloss of glazed ceramic tile based on 60-deg geometry.

Four new test methods being balloted for presentation to the Society are for: crazing resistance of fixed glazed ceramic whitewares by the thermal shock method, thermal shock resistance of glazed ceramic tile, warpage of ceramic tile, and bond strength of non-portland-cement installations.

In preparation is a method to determine the extractable lead from glazed surfaces when exposed to organic acids. The test can use either a colorimeter or turbidimeter and will determine soluble lead on the order of $\frac{1}{2}$ ppm.

The newly reconstituted task group on nonplastic (nonclay) materials is restricting its activity to particle size analysis in the range below 44 μ. Techniques under consideration include the use of electroformed sieves and sedimentation using the microcentrifuge.

The committee, jointly with Committee C-25 on Ceramics for Electronics, is developing a symposium on tension testing of ceramic whitewares to be presented at the next meeting in Toronto, in April, 1961.

Gold Devalued for Plating Silver

Among precious metals, both gold and silver are used as electrical contacts. However, gold plating over silver is not recommended. At the edge where the plating ends, the silver will react with sulfur in the air and creep over the gold, forming a layer of silver sulfide. A gold plating over copper is much better in this respect. These findings were reported by Dr. A. Keil, director of research, Durrwachter and Co., Pforzheim, Germany, speaking to the contacts group of Committee B-4 on Metallic Materials for Thermostats and for Electrical Resistance, Heating, and Contacts, meeting at Skytop, Pa. on Nov. 2. Dr. Keil expressed pleasure at being able to meet with the ASTM committee, there being no counterpart group in Germany where problems relating to electrical contacts may be discussed in open meeting. Dr. Keil showed photomicrographs of the growth of silver sulfide crystals in the form of "whiskers" which had been grown in the laboratory.

The thermostat metals subcommittee has about completed a bibliography on thermostat metals, to be published by the Society. Some of the subjects to be included are applications; bond testing; books on thermostat metals; cladding; corrosion; design; emissivity; fabrication; high-temperature materials and performance; mechanical, metallographic, and physical characteristics; shapes; standards; and thermal conductivity.

The committee has transferred its activity on wrought and cast alloys for structural use at high temperatures to Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys, where it was felt that such interests were more adequately represented.

New Methods To Be Added for Analysis of Soda-Lime Glass

AT A MEETING OF committee C-14 on Glass, October 13, at Bedford Springs, Pa., progress was reported on interlaboratory studies to establish methods to be added to Method C 169 covering the determination of calcium oxide, magnesium oxide, barium oxide, chlorine, sulfur trioxide, potassium oxide, arsenic trioxide, antimony trioxide, manganous oxide, and lead oxide. Interlaboratory studies are also being planned for the Method of Chemical Analysis of Glass Sand (C 146 – 56 T) as a result of test variations in a recently completed study.

Considerable revision is under way for Method C 240; the title will also be revised to read: "Methods of Test for Cellular Glass Insulating Block."

The committee is cooperating with the British Standards Institution in obtaining laboratory data for the boiling acid test on powdered glass in connection with the work of ISO/TC 48, Working Group F, on Quality of Glassware.

Blow Molding New Subject for Plastics Committee

Plastics shaped by fluid pressure, usually gases will be the subject for a new Section D of Subcommittee XV on Thermoplastic Materials of Committee D-20 on Plastics. The words "blow molding" may not be used in the title, though this is the class of product to be covered. Expansion of Committee D-20 activities into plastic shapes and products, approved by the committee at the 1960 Annual Meeting, had been prompted by a request from the Federal Housing Administration and the Building Research Advisory Board that the commitee undertake development of standards for plastics used in buildings. The committee agreed to establish projects in this area, based upon specific requests, considering each on its merits. The action to establish a blow-molding section was one of many at the Detroit meeting of the committee, Oct. 3–6.

A dyed (yellow) acrylic plastic chip has been approved by the committee for use in standardizing exposure conditions in artificial-weathering apparatus of the carbon-arc type, both with and without water spray. Work is in progress to extend application of this method to outdoor exposures.

The committee has started work on specifications for plastic pipe for use in drain and sewer applications, as well as for electrical conduit.

As an indication of the present work output, the following proposed new tentatives are now being balloted in the committee:

Method for Coefficient of Friction
Method for Particle Size (Sieve Analysis)

Recommended Practice for:
- Resistance to Fungi
- Injection Molding of Polystyrene
- Transfer Molding of Thermosetting Materials
- Sampling

Specification for:
- Styrene-Butadiene Molding and Extrusion Compounds
- Rigid PVC Sheet
- Tooling Plastic Casting Compounds

Plans are under way to publish a new edition of the ASTM Standards on Plastics early in 1961. The new book

will be changed approximately 30 per cent from the December, 1959, edition and will contain 27 new tentatives and 21 revisions.

New Committee on Ceramics for Electronics Gets Under Way

THE FIRST Meeting of the new Committee C-25 on Ceramics for Electronics was held in Milwaukee, Wis., on September 23, in conjunction with a meeting of the Electronics Division, American Ceramic Soc. The committee is exploring the needs of industry for guidance in its initial efforts. A classification of the work in this field, published by the American Ceramic Soc., contains definitions of terms that will serve as the first order of business for the Nomenclature Subcommittee.

Already under development are: a method for determining the compressive strength of high-alumina electrical insulating ceramics, methods for electrical insulating properties of ceramics at microwave frequencies, and methods to determine the high-temperature properties of these materials and their flexural strengths, particularly for miniature specimen sizes.

Work on the ferroelectrics has been channeled into three task-group projects: microwave-frequency test methods for ferroelectrics, process control tests for ferroelectrics, and chemical tests for certain raw materials that are generally used in the industry.

Four methods for nonmetallic materials that are nearing completion include: methods of test for ferrimagnetic resonance line width and for gyromagnetic ratio of nonmetallic magnetic materials, for complex dielectric constant of nonmetallic magnetic materials, and a method of testing nonmetallic magnetic cores to be used in a coincident current memory with a 2:1 selection ratio.

The first activity of the semiconductor program will be to classify these ceramic materials and to define a course for the development of necessary test methods. Interest in specialized ceramic-to-metal seals dominated the discussions concerning composite materials. Although the areas of interest are different from those of Committee F-1, liaison will be actively maintained with that committee.

Trechsler's Pea-Shooter Gunsight

Mathematisch-physikalische Salon, Dresden

IN THE light of great men and great inventions, one often overlooks the contributions of the "little men of science," artisans and instrument-makers. At no time were these more important than in the period around 1600. Christopher Trechsler the Elder, about whom little personal information is available, appears to have been employed as a master armorer in Dresden. His still prolific devices are of most ingenious construction, embellished with much decorative engraving. Among other things, he was the first to make wide use of fine micrometer screws for adjustment and leveling as well as measurement. This gunnery level, made by him in 1622, has such a leveling screw and is marked with scales showing the range of cannon balls of various types. Above the main indicator is a sighting device which consists of a "pea-shooter," to which the eye is applied; a scale of degrees enables the artilleryman to make corrections for the throw of his gun. The piece is preserved in the Mathematisch-physikalische Salon in Dresden.

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After 6 × 10^6 Specimen-hours—More Work Needed

Few tests in ASTM or anywhere else have been investigated more thoroughly than the Suggested Method for Corona Resistance, published in 1957 under auspices of Committee D-9 on Electrical Insulating Materials. Yet the method does not measure up to criteria the committee has set for publication as tentative. One company reported over 6 million specimen-hours of experience with the test. Another corona method —for measuring corona voltage and power—is considered satisfactory and is being balloted by the committee as a proposed tentative.

Among other activities of the committee at its meeting in Detroit, October 5–7, 1960, was a Symposium on Resistivity—Its Meaning and Significance. Symposium Chairman Andy Blanck spoke on dielectric absorption; Harold Endicott spoke on the same subject, treating especially the loss-of-charge method. Measurement of resistivity is not simply a matter of observing the instantaneous voltage and current relations across electrodes placed on a specimen. Indeed, the present Method D 257 uses 23 pages in describing how to make the measurement. Mr. Endicott

Technical Committee Notes

reported that a specimen of dielectric material may be charged as a capacitor, then quickly discharged and the voltage recovery observed. The same phenomena are involved as in charging, and curves can be superimposed. Both the charging and the loss-of-charge method are being investigated in the committee for possible revision of Method D 257.

Also on the symposium program were co-chairmen E. B. Curdts, who spoke on d-c methods for field testing insulation, and Prof. M. L. Young, speaking on the mechanism and physical significance of insulation resistance. Plans are to publish these papers as a group, either in the ASTM BULLETIN or a Special Technical Publication.

Elsewhere in the committee: the magnet wire subcommittee is submitting for committee ballot the colossal total of 16 proposed new tentative methods of test for magnet wire. A new section on dielectric films is being formed, and anyone interested in participating should get in touch with F. P. West of Consolidated Edison Co. in New York. A proposed new specification for copper-clad laminates will be balloted in committee—this material is used extensively as the base for printed-wiring electronic circuits.

New Test Completed for Antifreeze Foaming Tendencies

Completion of the glassware test for determining foaming tendencies of engine antifreezes was reported at the Nov. 9–10 meeting of Committee D-15 on Engine Antifreezes in New York. This beaker test, to be published in June, uses controlled conditions of aeration and temperature that will generally distinguish between coolants that have a tendency to foam excessively and those that are suitable for further evaluation. After a backlog of data using this test is built up, a precision section will be developed.

The results of the first collaborative study of the hose-burst test for determining the effects of engine antifreezes have shown that since the antifreeze does not come in contact with the reinforcing yarn, the test evaluates only the original strength of the hose. Work on the development of a test to determine loss in strength of automotive hose will continue, using possibly an immersion-type test.

New work includes the development of standard automotive paint panels to be used for evaluating a method to determine the staining characteristics of engine antifreezes. Methods for detecting various glycols in mixtures are also being investigated.

Preliminary work with the engine-block apparatus for bench-testing the corrosiveness of engine antifreezes was reviewed, and minor improvements of the apparatus were incorporated. The first interlaboratory study using the bench test was outlined. Three antifreezes will be tested using distilled water and corrosive waters of standard formulation and specimens cleaned by chemical techniques.

New SBR Rubber Announced

NUMBER 1570 has been assigned by ASTM Committee D-11 on Rubber and Rubber-Like Materials to a new styrene-butadiene rubber (SBR) recently brought on the market. Assignment of this number was made by Subcommittee XIII on Synthetic Elastomers, B. S. Garvey, chairman, in accordance with the Tentative Recommended Practice for Description of Styrene-Butadiene Rubbers (SBR) and Butadiene Rubbers (BR) (D 1419–60a T). It is interesting to note that this is the first instance in which a foreign company has desired to use the ASTM numbering system. A description of the new SBR rubber is as follows:

Number Assigned	570
Date assigned	9/11/60
Requested by	International Synthetic Rubber Co.
Distinctive feature	High viscosity
Close previous number, if any	...
Type	1500
Nominal temperature, deg Fahr	42
Activator	FRA
Shortstop	ND
Antoxidant	NST
Catalyst	OHP
Emulsifier	Mixed
Nominal bound styrene, per cent	23.5
Nominal conversion, per cent	60
Nominal Mooney viscosity, ML 1 + 4 (212 F), polymer	125
Nominal Mooney viscosity, MS 1 + 4 (212 F), compound	78
Coagulation	SA
Carbon black:	
Type	...
PHR	...
Oil:	
Type	...
PHR	...
Finishing	Normal

NOTE.—Abbreviations and symbols are defined as follows: FRA = free radical type, that is, iron pyrophosphate, peroxamine sulfoxylate. ND = nondiscoloring. NST = nonstaining. OHP = organic hydroperoxide. SA = salt acid.

Atmospheric Exposure Program Approved for Plated Die Castings

COMMITTEE B-8 on Electrodeposited Metallic Coatings has approved a program (program No. 7) to determine the effect of atmospheric weathering on copper-nickel-chromium coatings on zinc-based die castings.

Atmospheric exposure program No. 5, which is being exposed this winter, will determine the effectiveness of various types and thicknesses of chromium over nickel and copper-nickel coatings on low-alloy steels. Program No. 6 will determine the effects of the atmosphere on varying proportions of nickel and copper combinations as decorative finishes on aluminum.

An improved dye for the Method of Test for Sealing of Anodically Coated Aluminum (B 136) is being tested. Small amounts of the dye may be had for study purposes from director of research, Aluminum Company of America, Box 772, New Kensington, Pa. Aluminum panels having a variety of treatments of sulfuric and chromic acid anodized coatings will be subjected to accelerated and environmental tests.

Interest in the plating of precious metals has prompted a review of gold plating techniques. Those interested in developing recommendations for smooth, adherent electrodeposits of gold plating should get in touch with R. A. Ehrhardt, Bell Telephone Laboratories, Inc., Box 262, Murray Hill, N. J.

A series of 223 definitions of terms used in the electroplating industry are being readied for publication in 1961.

Inch Now Tied to Light Wave

THE INCH, for more than 70 years defined as a certain fraction of the length of a platinum iridium meter bar stored in Paris, is now defined as 41,929,399 wavelengths of the orange-red line of krypton 86. This is the result of action taken by the 11th General Conference of Weights and Measures, which met in Paris in October.

Since the wavelength of a specific kind of light is thought to be unchanging, adoption of the new length standard removes uncertainties about the stability of the primary standard, which had always accompanied use of a metal bar. Also, it will no longer be necessary for national standards organizations to calibrate their length standards against the Paris bar; the new standard is reproducible to great accuracy in any properly equipped laboratory. Some length measurements can now be made more accurately in terms of the new definition.

A Short Method for the Flame Photometric Determination of Magnesium, Manganic, Sodium, and Potassium Oxides in Portland Cement

By C. L. FORD

Existing methods for the flame photometric determination of magnesium, manganese, sodium, and potassium have been modified to permit the use of one set of standard calibration solutions for the flame photometric determination of the amounts of all four elements in portland cement. The development of the method is described. Supporting data showing accuracy and precision are presented. Details of the method are given in an appendix.

SHORT METHODS of analysis of portland cement with reasonable accuracy are desirable especially for plant control. Flame photometric methods have helped to meet this need, particularly in the determination of alkalies (sodium and potassium). It has been shown also (1)[1] that manganese as well as alkalies may be determined successively using one set of suitably prepared standard solutions for calibrations of the flame photometer, and one solution of a cement sample. This investigation was initiated to determine whether the combination method for manganese, sodium, and potassium could be altered to include magnesium.

Before this study was begun, several methods (2,3,4) were investigated to find the best one for determining magnesium only (or for magnesium oxide as it is commonly reported). The method selected (4) gave for the ten cements tested an average difference of only +0.01 per cent and a mean deviation of 0.05 per cent from the values by the ASTM (referee) Methods of Chemical Analysis of Portland Cement (C 114 – 58).[2]

In the search for a good combination method for magnesium, manganic, sodium, and potassium oxides, a number of modifications in the manner of preparation of both standard and cement solutions were tried. Only those are described later which proved sufficiently satisfactory to yield the data shown in the accompanying tables. It may be of interest, however, to discuss interferences that were noted in the emission of the several elements studied.

Experimental

Interferences

In experiments with different methods for magnesium oxide it was found that the one in which silicon, iron, and aluminum were not removed (2) gave the most erratic results. Since these elements interfered with the emission of magnesium, they were removed in the combination method as developed. Removal of iron and aluminum with ammonium hydroxide results in the formation of ammonium chloride; at first it was thought this would cause interference. Experiments were made in which compensating amounts of ammonium chloride were introduced into the standard calibrating solutions. In one set of tests with standard solutions containing added ammonium chloride, the solutions were strongly acid with hydrochloric acid; in another the acid present was neutralized with ammonium hydroxide to slight alkalinity (methyl red indicator). Whether the standard solutions were acid or slightly alkaline, however, the results for the samples were not as good as those obtained with comparable standard solutions without ammonium chloride. Acidifying the slightly alkaline sample solutions and further acidifying of the standard solutions were tried, but in both cases the additional hydrochloric acid caused interference with the emission of one or another of the elements being determined.

The effect of the removal of silicon dioxide (hereafter referred to as "silica") was studied. It was found that this caused an apparent depression of the emission of potassium resulting in lower values, in some cases, than the corresponding values by the ASTM Tentative (flame) Methods of Chemical Analysis of Portland Cement (C 114 – 58 T).[3] There is some evidence, however, that the emission of potassium is unduly enhanced when silica is not removed. This will be discussed later in more detail.

Sources of Method

The combination method was developed by combining suitable parts of the available methods listed below:

1. Sodium and potassium oxides: ASTM Methods of Chemical Analysis of Portland Cement (C 114 – 58 T), Sections 16, 17, and 18.
2. Manganic oxide: Diamond's method (5).
3. Magnesium oxide: Lone Star Cement Corp. method (4).

Apparatus

All tests were made with the Beckman Model DU spectrophotometer with No. 9200 flame and No. 4300 photomultiplier attachments using an oxyhydrogen flame. The Perkin-Elmer flame photometer could have been used for sodium and potassium, but this instrument lacked sufficient sensitivity for magnesium and manganese, hence the Beckman DU was used throughout this study.

Reagents

One-liter batches of stock solutions were prepared from analytical reagent-

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.
[2] 1958 Book of ASTM Standards, Part 4, p. 63.
[3] *Ibid.*, Part 4, p. 102.

C. L. FORD was an analytical consultant in the Research and Development Division of the Portland Cement Assn. before his retirement in April, 1960. For 38 years Mr. Ford worked successively as chemist, chief of analytical laboratories, and consultant. His work has included studies of methods for chemical analysis, and the determination of the fineness and density of portland cement. Recent studies have included flame photometric methods for the analysis of cement.

grade chemicals for the determinations of the various oxides. Preparation of stock solutions could be simplified somewhat by combining manganese, sodium, and potassium into one solution as shown in Table I. Magnesium and calcium solutions, however, have to be prepared separately, because different volumes of each are used for the standard solutions. For the purpose of this study the stock solutions were prepared as described in the Appendix.

Calibration of Apparatus and Procedure

These operations are described in detail in the Appendix.

Cements Used

The ten cements selected for test included National Bureau of Standards sample No. 177, four Portland Cement Association check samples, and five other type I cements. A considerable range of compositions was represented by these samples. One of them, No. 19444, was relatively high in magnesium and alkalies. Tests were also made of a portland blast-furnace slag cement, Type IS, but the magnesium oxide results were unsatisfactory under the conditions of the test, hence it was omitted from this report. However, the results for the manganic and potassium oxide content of this Type IS cement were very good and for sodium oxide fairly good.

Discussion

1. Magnesium Oxide

It may be seen from Table II that the magnesium oxide values tended to be a little low compared with the values by the ASTM gravimetric method.[2] The differences averaged −0.093 per cent. The maximum difference was −0.20 per cent and the minimum +0.02 per cent. While the accuracy is not as good as might be desired for a referee method, the precision (see individual test data) is very good, and it is believed the method is quite good for a rapid control procedure.

2. Manganic Oxide

The results for manganic oxide, also shown in Table II, were very good. The average of the differences from the referee values was only +0.006 per cent. The maximum difference was only +0.02 per cent and the minimum was zero. In fact, the manganic oxide results were better than those obtained in the author's method (1) for manganese and alkalies.

3. Potassium Oxide

A study of average results obtained by the combination method (column 8, Table III) revealed a definite trend toward low values, particularly for cements of relatively high potassium oxide content, when compared with the ASTM values by the Perkin-Elmer flame photometer shown in column 3. Results for the same cements showed a similar lower trend when analyzed by the ASTM flame method modified to include removal of silica by a single evaporation with hydrochloric acid. The latter results (column 4) as well as the results strictly according to the ASTM flame procedure (column 3) are also shown in the table. There seems to be some justification for the belief that the lower values are more nearly correct. For example, a few representative comparisons with ASTM gravimetric referee method results are shown below:

POTASSIUM OXIDE (K_2O) DETERMINATIONS

Cement	ASTM Gravimetric (Referee)	ASTM Flame Photometric	
		SiO_2 Removed	SiO_2 Not Removed
PCA Ck 1	0.57	0.56	0.59
PCA Ck 3	0.67	0.66	0.70
LTS 18	0.13	0.13	0.14

Columns 9 and 10 of Table III show the differences between the combination method results (column 8) and the ASTM method results obtained when silica was not removed (column 3), and the values when the silica was removed (column 4), respectively. It is quite evident that the latter differences in column 10 are very low, with a maxi-

TABLE I.—STANDARD SOLUTIONS.

Solution	Designation of Standard: Concentration: Magnesium (Expressed as MgO), ppm	Designation of Standard: Concentration: Manganese and Alkali (Expressed as Mn_2O_3, Na_2O, or K_2O), ppm	Composition of Standard: Calcium Stock Solution, ml	Composition of Standard: Magnesium Stock Solution, ml	Composition of Standard: Manganese-Alkali Stock Solution, ml	Final Volume of Solution, ml
No. 1	500	100	200	100	200	2000
No. 2	400	75	100	40	75	1000
No. 3	300	50	100	30	50	1000
No. 4	200	25	100	20	25	1000
No. 5	100	10	100	10	10	1000
No. 6	0	0	100	0	0	1000
No. 7	0	100	0[a]	0	100	1000

[a] The calcium-free solution is used only in determining the correct positions of the wavelength selector for maximum responses to Mn_2O_3, Na_2O, and K_2O.

TABLE II.—MAGNESIUM AND MANGANIC OXIDE VALUES BY ASTM AND FLAME PHOTOMETRIC METHODS.

Cement: Number	Cement: Type	ASTM Referee[a]	Method: Flame Photometer, Beckman DU: Test L	Test M	Test O	Average	Difference[b]
			MgO, per cent				
B of S 177	..	2.45	2.40	2.35	2.40	2.38	−0.07
PCA Ck 1	I	2.70	2.50	2.50	2.50	2.50	−0.20
PCA Ck 2	I	0.78	0.80	0.80	0.80	0.80	+0.02
PCA Ck 3	I	3.05	2.85	2.85	2.90	2.87	−0.18
PCA Ck 4	II	0.92	0.85	0.80	0.85	0.83	−0.09
LTS 18	I	2.11	2.05	2.05	2.10	2.07	−0.04
19269	I	2.56	2.40	2.45	2.45	2.43	−0.13
19270	I	2.60	(2.30)[c]	2.45	2.45	2.45	−0.15
19272	I	1.50	1.40	1.40	1.38	1.39	−0.11
19444	I	4.83	4.90	4.80	4.85	4.85	+0.02
			Average Difference				−0.093
			Mean Deviation				0.101
			Mn_2O_3, per cent				
B of S 177	..	0.05	0.05	0.05	0.05	0.05	0
PCA Ck 1	I	0.29	0.29	0.29	0.31	0.30	+0.01
PCA Ck 2	I	0.04	0.05	0.05	0.05	0.05	+0.01
PCA Ck 3	I	0.09	0.11	0.09	0.11	0.10	+0.01
PCA Ck 4	II	0.05	0.06	0.05	0.05	0.05	0
LTS 18	I	0.45	0.48	0.46	0.46	0.47	+0.02
19269	I	0.58	0.62	0.58	0.59	0.60	+0.02
19270	I	0.25	0.24	0.22	0.26	0.24	−0.01
19272	I	0.18	0.18	0.17	0.18	0.18	0
19444	I	0.04	0.04	0.04	0.05	0.04	0
			Average Difference				+0.006
			Mean Deviation				0.008

[a] Analysis of B of S No. 177 certified by National Bureau of Standards; all others are the average of two or more tests by ASTM referee methods (C 114).
[b] Differences from values by ASTM methods.
[c] Value in parentheses is not included in average.

mum of −0.02 per cent and an average of +0.002 per cent. The differences in column 9 from the ASTM (silica not removed) method are much higher, with a maximum of −0.11 per cent and an average of −0.030 per cent. On the basis of the above discussion, it will be seen that the method is very satisfactory for potassium oxide, when allowance is made for the undesirable enhancing effect of silica which occurs when the ASTM flame method is strictly followed. In other words, it is believed that the prior removal of silica results in more accurate flame photometric values for potassium oxide.

4. Sodium Oxide

The removal of silica has shown very little effect on the sodium oxide values by the Perkin-Elmer flame photometer. There is a slight trend toward higher values to be noted in column 4 in Table III showing SiO_2-removed results. The values by the combination method using the Beckman DU flame photometer tend to be slightly higher than either the ASTM or SiO_2-removed values, but well within the limits of accuracy. The average difference from the sodium oxide values by the ASTM method is only +0.017 per cent and from the SiO_2-removed values is even smaller, +0.009 per cent, but the difference between the two is negligible. It thus appears that the combination method is very satisfactory for the determination of sodium oxide.

5. Total Alkalies as Sodium Oxide

The Perkin-Elmer ASTM and SiO_2-removed sodium and potassium oxide values and the average combination method values were all calculated to total alkalies as sodium oxide as shown in the bottom section of Table III.

TABLE III.—SODIUM AND POTASSIUM OXIDE VALUES BY FLAME PHOTOMETRY.

Cement		Flame Photometer and Method							
		Perkin-Elmer		Beckman DU SiO_2 and "R_2O_3" removed					
			SiO_2 removed[b]	Test			Average	Difference	
Number	Type	ASTM A[a]	B	L	M	O		A	B
1	2	3	4	5	6	7	8	9	10
				Na_2O, per cent					
B of S 177	..	0.14	0.13	0.14	0.15	0.16	0.15	+0.01	+0.02
PCA Ck 1	I	0.25	0.25	0.25	0.25	0.27	0.26	+0.01	+0.01
PCA Ck 2	I	0.06	0.07	0.07	0.08	0.08	0.08	+0.02	+0.01
PCA Ck 3	I	0.26	0.27	0.30	0.28	0.30	0.29	+0.03	+0.02
PCA Ck 4	II	0.60	0.61	0.60	0.61	0.60	0.60	0	−0.01
LTS 18	I	0.15	0.15	0.17	0.16	0.17	0.17	+0.02	+0.02
19269	I	0.09	0.11	0.12	0.12	0.12	0.12	+0.03	+0.01
19270	I	0.34	0.35	0.35	0.37	0.34	0.35	+0.01	0
19272	I	0.31	0.32	0.31	0.33	0.32	0.32	+0.01	0
19444	I	0.53	0.55	0.56	0.56	0.55	0.56	+0.03	+0.01
				Average Difference				+0.017	+0.009
				Mean Deviation				0.017	0.011
				K_2O, per cent					
B of S 177	..	0.57	0.53	0.54	0.53	0.54	0.54	−0.03	+0.01
PCA Ck 1	I	0.59	0.56	0.57	0.56	0.56	0.56	−0.03	0
PCA Ck 2	I	0.25	0.24	0.24	0.24	0.24	0.24	−0.01	0
PCA Ck 3	I	0.70	0.66	0.66	0.64	0.66	0.65	−0.05	−0.01
PCA Ck 4	II	0.14	0.13	0.14	0.14	0.14	0.14	0	+0.01
LTS 18	I	0.14	0.13	0.14	0.14	0.13	0.14	0	+0.01
19269	I	0.15	0.13	0.14	0.14	0.14	0.14	−0.01	+0.01
19270	I	0.58	0.56	0.57	0.57	0.54	0.56	−0.02	0
19272	I	0.61	0.56	0.59	0.56	0.55	0.57	−0.04	+0.01
19444	I	1.00	0.91	0.89	0.88	0.89	0.89	−0.11	−0.02
				Average Difference				−0.030	+0.002
				Mean Deviation				0.030	0.008
				$Na_2O + K_2O$ as Na_2O[c], per cent					
B of S 177	..	0.52	0.48	...	...	...	0.51	−0.01	+0.03
PCA Ck 1	I	0.64	0.62	...	...	...	0.63	−0.01	+0.01
PCA Ck 2	I	0.22	0.23	...	...	...	0.24	+0.02	+0.01
PCA Ck 3	I	0.72	0.70	...	...	...	0.72	0	+0.02
PCA Ck 4	II	0.69	0.70	...	...	...	0.69	0	−0.01
LTS 18	I	0.24	0.24	...	...	...	0.26	+0.02	+0.02
19269	I	0.19	0.20	...	...	...	0.21	+0.02	+0.01
19270	I	0.72	0.72	...	...	...	0.72	0	0
19272	I	0.71	0.69	...	...	...	0.70	−0.01	+0.01
19444	I	1.19	1.15	...	...	...	1.15	−0.04	0
				Average Difference				−0.001	+0.010
				Mean Deviation				0.013	0.012

[a] Analysis of B of S No. 177 certified by National Bureau of Standards; PCA check samples are the average of duplicate analyses by two or more analysts; others are the average of two or more analyses by one analyst.

[b] Values are the average of two or more analyses by one analyst; SiO_2 removed by a single evaporation with HCl (1:1) before flame test.

[c] Total as $Na_2O = Na_2O + 0.658 \times K_2O$.

It will be noted that the differences (columns 9 and 10) of the average combination method values (column 8) from either of the Perkin-Elmer values (columns 3 and 4) do not exceed 0.04 per cent, and only in two cases do the individual differences exceed 0.02 per cent. These results indicate that the method would be as good as the ASTM flame photometric procedure for total alkalies.

Time Requirements

The time required for preparing a single sample of cement by the combination method for magnesium, manganic, sodium, and potassium oxides was found to be about 50 min working time and a little over 3 hr elapsed time.

The time required for the preparation of stock solutions, calibration of the flame photometer, and analysis of a sample would be about the same regardless of the method. The time required for the preparation of standard calibrating solutions would be considerably less than by other methods because only one set is needed, the required amount of each stock solution being added to only one flask for each concentration. When other methods are used there is the nuisance of keeping several sets of standard solutions on hand and having to change from one set to another.

Further, by the older methods, one sample would be prepared for sodium, potassium, and manganic oxide requiring about 30 min working time and 1 hr elapsed time. Another sample would have to be prepared for magnesium oxide requiring about the same time as shown above for the combination method, namely, 50 min working time and a little over 3 hr elapsed time. By using the combination method, the latter times would cover the entire preparation for all four oxides.

A time study showed the time required (including preliminary separations) for determining the magnesium oxide content of a group of six samples by the ASTM gravimetric (referee) method to be 8 hr, 20 min working time and 20 hr, 50 min elapsed time. The latter did not include overnight periods. The working time required for the analysis of a single sample, of course, would be less, but the elapsed time would be nearly as great as shown above. The time requirements of the ASTM alternate methods for magnesium oxide are not available.

Summary and Conclusions

A flame photometric combination method has been developed whereby one set of standard calibrating solutions and one solution of cement are all that are required for the successive analysis

of the latter for magnesium, manganic, sodium, and potassium oxides. The accuracy of the method is excellent for manganic oxide, and good for magnesium, sodium, and potassium oxides. The precision is very good for all four oxides. Use of the procedure leads to more rapid and convenient analyses. The method is, therefore, recommended as a rapid control procedure when all four oxides must be determined. The ASTM flame photometric method is, of course, simpler when alkali values only are required. However, some evidence has been presented to indicate that the potassium oxide results were more accurate when silica and the ammonium hydroxide group were removed.

Acknowledgment:

Thanks are extended to Mr. L. R. Pritchard for permission to use the Lone Star Cement Corporation's unpublished method for the flame photometric determination of magnesium as a basis for the method of preparation of the sample and for the determination of magnesium as presented in this paper.

APPENDIX

Short Method of Analysis of Portland Cement for Magnesium, Manganic, Sodium, and Potassium Oxides by Flame Photometry

Scope

1. This method of analysis is intended for successively determining the magnesium, manganic, sodium, and potassium oxide contents of cement by flame photometry using one solution of a sample and one set of standard solutions.

Apparatus

2. (*a*) A Beckman Model DU spectrophotometer with Model 9200 flame attachment, oxyhydrogen burner, and Model 4300 photomultiplier.

(*b*) Cylinders of compressed oxygen and hydrogen with reducing valves.

Reagents

3. (*a*) *Calcium Chloride Stock Solution.*—Add 300 ml of water to 112.5 g of calcium carbonate ($CaCO_3$) (NOTE 1) in a 1500-ml or 2000-ml beaker. While stirring, slowly add 500 ml of reagent-grade hydrochloric acid (HCl, sp gr 1.18). Cool the solution to room temperature, filter into a 1-liter volumetric flask, dilute to the mark, and mix thoroughly. This solution contains the equivalent of 63,000 ppm (6.3 per cent) of calcium oxide (CaO).

NOTE 1.—The calcium carbonate shall be reagent-grade. "low-alkali" $CaCO_3$ carrying a specification limit of 0.020 per cent total alkalies as sulfate and of 0.01 magnesium. The purchaser should assure himself that these specifications are met.

(*b*) *Magnesium Stock Solution.*—Dissolve in water 50.4 g of reagent-grade magnesium chloride hexahydrate ($MgCl_2 \cdot 6H_2O$) (NOTE 2), dilute to 1 liter in a volumetric flask and mix thoroughly. This solution contains the equivalent of 10,000 ppm (1.0 per cent) of magnesium oxide (MgO).

NOTE 2.—Since $MgCl_2 \cdot 6H_2O$ is a deliquescent salt, the desired amount should be taken from a bottle that has been tightly sealed—preferably a new one.

(*c*) *Manganese-Alkali Stock Solution.*—Dissolve in water 1.8858 g of reagent-grade sodium chloride (NaCl), 1.5830 g of reagent-grade potassium chloride (KCl) and 2.1412 g (or the proportionate amount as determined by analysis—see NOTE 3) of reagent-grade manganous sulfate monohydrate ($MnSO_4 \cdot H_2O$) (all previously dried at 105 C for several hours—NOTE 4), dilute to 1 liter in a volumetric flask, and mix thoroughly. This solution contains the equivalent of 1000 ppm (0.10 per cent) each of sodium oxide (Na_2O), potassium oxide (K_2O), and manganic oxide (Mn_2O_3).

NOTE 3.—The $MnSO_4 \cdot H_2O$ may not be sufficiently pure to use the theoretical weight of 2.1412 g (equivalent to 1.0000 g of Mn_2O_3). Before use in the stock solution prepare a trial solution containing 2.1412 g per liter. Analyze 5- and 10-ml aliquots of this solution for Mn_2O_3 according to ASTM Methods C 114 – 58, Sections 26 and 27. Correct the weight of $MnSO_4 \cdot H_2O$ used in the stock solution so that the latter will contain the equivalent of 1.0000 g of Mn_2O_3.

NOTE 4.—The temperature must be kept well below 117 C, the temperature at which $MnSO_4 \cdot H_2O$ becomes unstable.

(*d*) *Standard Solutions.*—Prepare the standard solutions prescribed in Table I. The required volumes of magnesium and manganese-alkali stock solutions shall be measured in calibrated pipets or burets, and the $CaCl_2$ stock solution may be measured in a graduated cylinder. Each solution shall be placed in a volumetric flask, diluted to the volume indicated in Table I and mixed thoroughly. The solutions shall be stored in bottles of acid-resistant glass with ground-glass or rubber stoppers.

Calibration of Apparatus

4. (*a*) *General.*—The instructions given below apply to the Beckman Model DU spectrophotometer with accessories. For a description and further details of operation of the Beckman DU other than given below, refer to Beckman Instruments, Inc., instructions (*6*). Further, some of the instructions that follow for settings and adjustments may have to be varied with different instruments. The manufacturer's instructions for oxygen and hydrogen pressures for the burner used should be followed. Slit widths and photomultiplier settings may have to be varied with different burners. Because of unavoidable fluctuations of the instrument, frequent calibrations are advisable.

TABLE IV.—FLAME PHOTOMETER SETTINGS.

Metal	Wavelength, mμ	Phototube	Load Resistor, megohms	Slit, mm	Selector Switch	Photomultiplier
Mg.....	371	Blue	22	0.4–0.6	0.1	2–3
Mn.....	403.3	Blue	22	0.1–0.3	0.1	Full
Na	589	Blue	22	0.01–0.02	0.1	2–3
K	768	Red	10000[a]	0.05–0.08	0.1	Off

[a] With some instruments a 2000-megohm resistor may give better performance.

(*b*) *Warmup of Apparatus and Adjustment of Flame.*—Set the selector switch to 0.1 and select the proper phototube, resistor, and photomultiplier setting (see Table IV). Allow the electrical system about 1 hr to warm up. See that the shutter switch is off and that the fuel and oxygen regulators on the control panel are closed. At the end of the warmup period, open the tank valves and adjust the pressure regulators to about 30 psi for oxygen and 10 psi for hydrogen. Next, open the oxygen regulator on the control panel to about 10 psi, then, while holding a match near and just below the tip of the burner, open the hydrogen regulator to about 4 psi. Fill one of the 5-ml sample beakers with a solution containing sodium and move it under the capillary by rotating the sample positioner control. Adjust the visible yellow flame to a height of about 2½ in. by adjusting the fuel needle valve on the side of the pressure control panel and, if necessary, varying slightly the pressures shown above. Remove the beaker, replace with a beaker of distilled water and allow the latter to atomize for 15 to 30 sec to prevent the formation of salt incrustations on the burner tip.

Important: This must be done each time after any solution is used in the flame.

(*c*) *Calibration Procedure:*

(*1*) Rotate the dark current control to zero the meter needle. Set the instrument for the element to be determined as shown in Table IV.

(*2*) Set the wavelength dial to the desired point for the element to be determined (NOTE 5), then check for maximum response as follows: Set the transmittance dial at 100 per cent. Atomize the calcium-free standard solution (No. 7 for manganese, sodium, and potassium) into the flame, turn the shutter switch on, and adjust the meter needle to zero with the sensitivity control. Move the wavelength dial control slightly to either side until, after adjustment of the meter needle to zero (NOTE 6), further changing of the wavelength produces no movement of the needle to the left. Turn the shutter switch off, remove the solution and atomize distilled water. The above procedure must be followed for manganese, sodium, and potassium.

NOTE 5.—A check for maximum response of magnesium is not necessary.

NOTE 6.—If it is impossible to zero the meter needle with the sensitivity control, it may be necessary to vary the slit widths from the values shown in Table IV.

(*3*) With the shutter closed, check the meter and, if necessary, zero the needle with the dark current control (NOTE 7). With the transmittance dial still set at 100, atomize into the flame standard solution No. 1. Open the shutter and zero the meter needle with the sensitivity control.

NOTE 7.—If the needle has a tendency to drift with the dark current only, it should be zeroed (with the shutter closed) before each transmittance reading of a standard or sample solution.

(*4*) Next, after atomizing distilled water, atomize standard solution No. 2 and zero the needle with the transmittance dial. Check the reading of solution No. 1 and if it has changed from 100, reset the meter to zero with the sensitivity control. Repeat alternately with standard solutions Nos. 1 and 2 until there is less than one transmittance dial division change in the respective readings. Record the transmittance values as "gross luminosity."

(*5*) Repeat the above procedure with each of the other standard solutions containing calcium (Nos. 3, 4, 5, and 6) and record the readings as "gross luminosity" (NOTE 8).

NOTE 8.—The reading obtained for the solution containing calcium, but no magnesium, manganese, or alkalies (No. 6), represents the blank or background emission correction to be subtracted from all readings. This applies to solutions of cement as well as standard solutions, since the enhancement of the emission of the above elements has been found to be due almost entirely to calcium.

(*6*) Correct the gross luminosity readings for the background emission. From the net luminosity values thus obtained, plot calibration curves for each oxide using cross-section paper of such type that each division on the ordinate represents a transmittance reading of one, and each division on the abscissa represents a magnesium oxide concentration of 5 ppm, or 0.05 per cent, or a manganic, sodium, or potassium oxide concentration of 1 ppm, or 0.01 per cent.

(*d*) *Shutdown of Apparatus.*—Shut down the instrument in the following order: close the fuel tank valve and regulator, the oxygen tank valve and regulator, then the regulators on the control panel. Turn the selector and photomultiplier switches to "off."

Procedure

5. (*a*) *Preparation of the Solution of Cement.*—Grind a representative sample of the cement to pass a 100-mesh sieve and remix thoroughly. Place 1.000 g of the sample into a 250-ml beaker and disperse with 20 ml of water, using a swirling motion of the beaker. While still swirling, add 5 ml of HCl (sp gr 1.18) all at once. Break up with a rubber policeman any lumps of cement remaining undissolved. Rinse the policeman and wash down the sides of the beaker with a small amount of water. Place the beaker under an infrared heat lamp (NOTE 9) and evaporate the contents to dryness. After cooling, add 15 ml of a solution containing one volume of hydrochloric acid diluted with one volume of water (HCl 1:1) and place the covered beaker on a steam bath for 15 min, then remove and add 15 ml of hot water. To precipitate iron and aluminum ("R_2O_3"), add a solution containing one volume of ammonium hydroxide diluted with one volume of water (NH_4OH 1:1) until a slight precipitate forms, then several drops of methyl red solution, then more NH_4OH (1:1) until the solution is distinctly yellow. Bring the solution back to a red color with the necessary amount of HCl (1:1) added dropwise, then very carefully add NH_4OH (1:1) dropwise until the solution is just yellow, then one drop in excess (NOTE 10). Boil the resulting suspension of silica (SiO_2) and "R_2O_3" rapidly for 1 min, allow to settle, and filter through an 11-cm Whatman No. 41 (or equivalent) filter paper into a calibrated 100-ml volumetric flask. Wash the beaker and paper thoroughly with hot water. Cool the contents of the flask to a temperature which shall closely approximate that of the standard solutions when the apparatus was calibrated, dilute to 100 ml, and mix the solution thoroughly.

NOTE 9.—A steam bath could be used, but a lamp is faster and dries more completely so that oven baking to dehydrate SiO_2 is not required.

NOTE 10.—Careful addition of NH_4OH (1:1) to slight alkalinity to methyl red is necessary to get consistent MgO results.

(*b*) *Determination of MgO.*—Prepare the apparatus as described in Section 4, (*b*) and (*c*) (*1*). Atomize standard solution No. 1 and, with the transmittance dial set at 100, zero the meter needle with the sensitivity control.

Following these adjustments, atomize the cement solution and note the transmittance reading after the meter needle has been brought to zero with the transmittance dial. Select the standard solution closest to the cement solution in MgO content and observe its transmittance reading with the meter needle again brought to zero. This value should agree within one division on the transmittance dial with the value established during calibration of the apparatus. If it does not, reset the transmittance dial to the original calibration point and zero the needle with the sensitivity control. Check the reading of standard solution No. 1, and if necessary, readjust to a transmittance of 100. Finally, alternately use the unknown solution and the closest standard solution until readings for the unknown agree within one division on the transmittance dial, and readings for the standard similarly agree with the calibration point. Record as "gross luminosity" the average of the last two transmittance readings obtained for the unknown solution. Check the blank or background correction previously obtained with standard solution No. 6.

(*c*) *Determination of Mn_2O_3, Na_2O, and K_2O.*—Determine Mn_2O_3, Na_2O, and K_2O as directed in paragraph (*b*) except that the controls shall be set as described in Table IV. Set the wavelength dial to the point of maximum response to Mn_2O_3, Na_2O, or K_2O by the use of the standard calcium-free solution (No. 7) as described in Section 4(*c*), (*1*) and (*2*).

(*d*) *Calculations and Reports.*—Correct the average of transmittance dial readings for background emission. Using the net luminosity values for MgO, Mn_2O_3, Na_2O, and K_2O in the unknown sample, read the percentage of each oxide from its respective calibration curve. Report MgO to the nearest 0.05 per cent and Mn_2O_3, Na_2O, and K_2O to the nearest 0.01 per cent.

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Properties of Some Copper Alloys at Elevated Temperatures

By C. H. CROWE

In the construction of field poles for synchronous machines, copper and various copper alloys are used for the amortisseur bars. These bars may be subject to quite high temperatures for short intervals of time when the machines are started. The purpose of this investigation is to provide design engineers with reasonably correct information covering the short-time mechanical strength and electrical resistivity of a number of commercially available copper alloys at temperatures up to 500 C. Available information in the technical literature is quite sketchy, especially at temperatures over 250 C.

Test Specimens

Bars $\frac{1}{2}$ in. in diameter were used for all tests. All bars were annealed at about 550 C for 1 hr before testing.

Tension Testing Procedure

Test bars about 16 in. long were cut, and a steel collar approximately $\frac{3}{4}$ in. long was silver brazed on each end to provide a means of gripping the bar.

The major heating unit was an old-style carbon combustion furnace, but in order to attain uniform temperature throughout the length of the bar, auxiliary heaters were designed for the ends. By means of variable resistors on each of the three heating units it was found possible to maintain the desired temperatures within ±5 C. Three thermocouples were brazed on the bar for measuring the temperature at the center and both ends. Figure 1 illustrates the tension-test setup with the furnace open.

The speed of the testing machine was:

Up to yield strength..... 0.001 in per in. per min.
Above yield strength..... 0.1 in. per in. per min.

The rather slow initial testing speed was chosen so as to assist in maintaining uniform temperature of the test specimen.

In most cases two tests were made at each temperature; the data in Table I are the averages of these tests.

Yield strength was determined at 0.2 per cent offset. While the extensometer was attached to the loading system, the accuracy of the yield strength determinations was checked several times at room temperature against an extensometer attached directly to the specimen, and connected with a high magnification stress-strain recorder. Good agreement was attained at offsets down to 0.1 per cent.

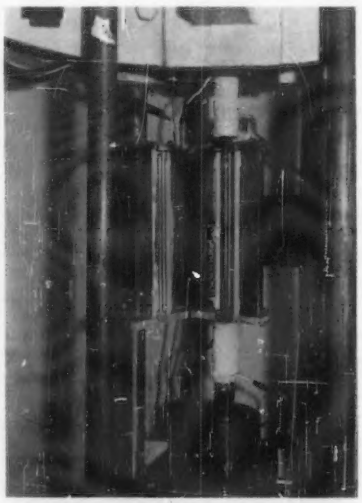

Fig. 1.—Tension test setup in open furnace.

Resistivity Tests

Test specimens approximately $\frac{1}{2}$ in. in diameter and 8 in. long were used. Heavy conductors were brazed to the ends, and a thermocouple was brazed to the middle of the bar. The voltage-drop leads, chosen so as to minimize thermal emf, were brazed on about $\frac{1}{2}$ in. from the ends. The specimen was placed in a well insulated muffle furnace, and readings were taken at room temperature and at 100 C intervals up to 500 C. Thermal emf was measured at each temperature before applying the current, and correction was made accordingly.

The sensitivity of the potentiometer was 2 μv per mm deflection of the galvanometer. The results are shown in Fig. 2.

The average temperature coefficients of resistivity calculated over the whole

TABLE I.—TENSILE AND YIELD STRENGTH, PSI.

Material	25 C		300 C		500 C	
	Yield	Ultimate	Yield	Ultimate	Yield	Ultimate
Cu 99.9, electrolytic tough pitch	6 150	30 400	4 980	19 000	3 570	10 000
Cu 95, Zn 5	6 900	33 500	5 280	23 500	4 490	13 380
Cu 90, Zn 10	9 650	37 000	7 540	26 100	6 180	13 700
Cu 85, Zn 15	12 500	39 500	10 750	30 600	7 510	14 500
Cu 70, Zn 30	12 850	47 000	11 750	34 700	4 600	11 500
Cu 95, Sn 5	22 000	49 500	18 000	42 800	10 500	19 000
Cu 90, Sn 10	22 600	62 800	18 200	32 000	12 500	19 500
Cu 98.25, Si 1.5, Mn 0.25	13 800	40 300	11 100	31 800	6 640	16 180
Cu 90.75, Al 7.25, Si 2.0	55 000	90 800	47 200	65 200	6 600	12 750
Cu 95.8, Si 3.1, Mn 1.1	26 300	66 500	18 000	44 800	7 600	14 700
Cu 58.5, Zn 39.25, Sn 1.0, Fe 1.0, Mn 0.25	33 300	70 700	18 800	29 800	NIL	3 000
Cu 82, Al 9.5, Ni 5, Fe 2.5, Mn 1	104 000	130 000	67 500	87 500	20 000	23 700
Ni 63 to 70, Cu balance	63 000	92 000	62 500	85 000	40 600	62 000

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range of testing are shown in Table II, which also gives the nominal composition of the alloys and the corresponding ASTM specification.

Remarks

It may be noted that while the tensile properties of the copper-zinc alloys increase with increased zinc content at room temperature and at 300 C, a decrease occurs at 500 C after the zinc has passed the 15 per cent mark. This is particularly noticeable with the manganese-bronze alloy containing 39 per cent zinc, in which the metal creeps at a very rapid rate at 500 C.

TABLE II.—AVERAGE TEMPERATURE COEFFICIENTS OF RESISTIVITY.

Alloy Symbol	Nominal Composition, per cent	ASTM Designation[a]	Temperature Coefficient of Resistivity, per deg Cent
A	Cu 99.9, electrolytic tough pitch	B 133	0.0048
B	Cu 95, Zn 5	...	0.0025
C	Cu 90, Zn 10	...	0.0021
D	Cu 85, Zn 15	...	0.0019
E	Cu 70, Zn 30	...	0.0017
F	Cu 95, Sn 5	B 139, Alloy A	0.00074
G	Cu 90, Sn 10	B 139, Alloy D	0.00060
H	Cu 98.25, Si 1.5, Mn 0.25	B 98, Alloy B	0.00056
J	Cu 90.75, Al 7.25, Si 2.0	B 150, Alloy 1	0.00080
K	Cu 95.8, Si 3.1, Mn 1.1	B 98, Alloy A	0.00030
L	Cu 58.5, Zn 39.25, Sn 1.0, Fe 1.0, Mn 0.25	B 138, Alloy A	0.0020
M	Cu 82, Al 9.5, Ni 5, Fe 2.5, Mn 1	B 150, Alloy 2	0.00050
N	Ni 63 to 70, Cu balance	B 164	0.00040

[a] 1958 Book of ASTM Standards, Part 2.

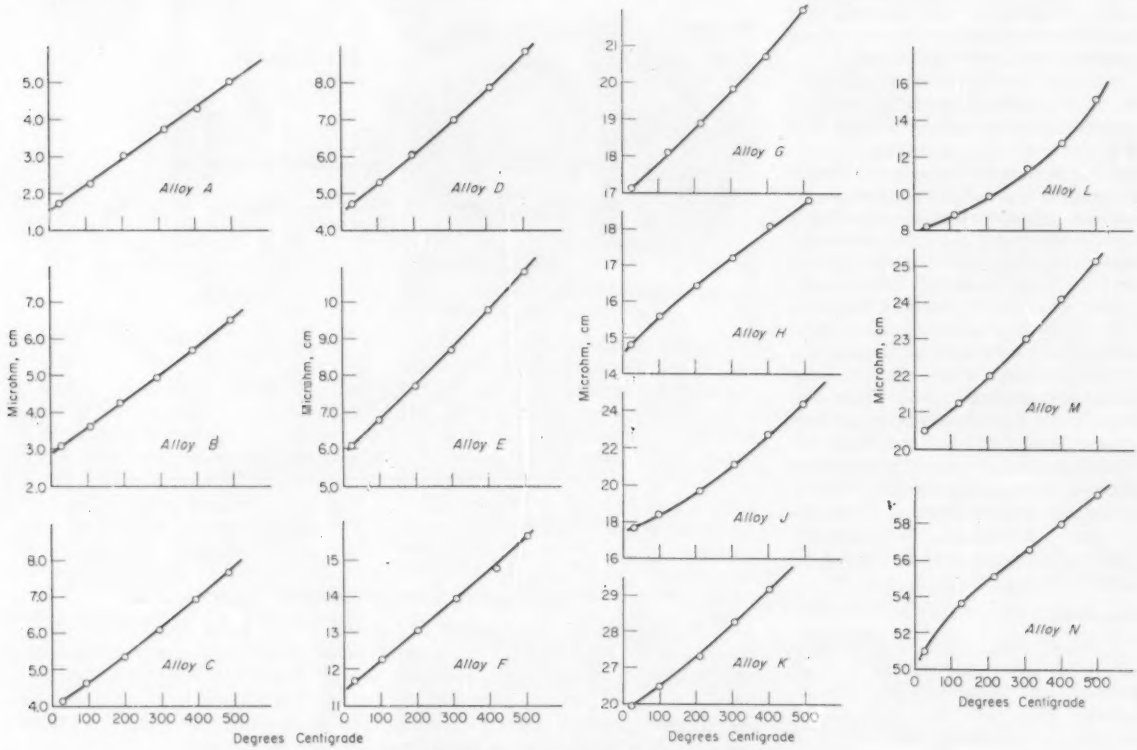

Fig. 2.—Temperature versus coefficient of resistivity.

The tensile strength of the 90:10 copper-tin alloy at 300 C appears out of line with the results obtained on the 95:5 alloy. A check test was made on a different heat of metal and the same results were obtained.

The temperature coefficient of resistance of the nickel-copper alloy changes rapidly at about 125 C.

Acknowledgment:

Grateful acknowledgment is expressed for the major assistance provided by E. C. Elgar, W. C. Jones, and L. G. Brown in the design and construction of the auxiliary heaters and their extensive advice in respect to the heat and electrical measurements.

Portable Adhesion Testing Device

By B. M. O'KELLY

SEVERAL inquiries concerning the adequacy of a plaster bond on the job motivated the development of a portable adhesion testing apparatus. It was hoped that plaster bond could be tested in the field with a portable device. Field conditions could then be compared with laboratory findings. Although descriptions of devices and techniques satisfying the above requirements have been published,[1] it was believed that some improvement in design over those published was possible and desirable.

Attempts by the author to reproduce the work of Peter[2] on the adhesion of gypsum plaster to various bases showed that this technique, involving the embedding of various shapes in the plaster application, was subject to grave shortcomings. A system was accordingly devised which did not involve the embedding of any object in the applied plaster. Unfortunately, Peter's philosophy was initially followed to the extent of using a panel $9\frac{1}{2}$ in. square. Such a panel works well with assemblies of high adhesion (for example, bond plaster on concrete), but where adhesion is not high, localized strains lead to premature bond failure. It is believed that there is no hope of success in adhesion work unless the bond test is carried out on a specimen of small surface area. Accordingly, 2-in. diameter circular disks were used finally for all adhesion tests.

Apparatus

A device using compressed gas as a source of power was designed, constructed, and found to operate satisfactorily (Fig. 1). The principle of operation is, essentially, application of pressure between two neoprene gaskets to produce a net upward force, since the upper gasket has a larger area than the lower. At the same time, no extraneous frictional or other restraining force is introduced. The compressed gas source is attached to the intake side of a manual-loading pressure regulator.[3] The output from the regulator is fed to the device and to a sensitive pressure gage. The device was calibrated by mounting it in a testing machine and measuring the total load (as registered on the testing machine scale) resulting from a given air pressure (measured on the pressure gage). Figure 2 shows that the calibration curve is comparatively linear.

Figure 3 shows the assembled adhesion pressure regulator, pressure gage, and testing device. The adhesion testing device alone weighs 4 lb 3 oz.

Procedure

The technique used in measuring adhesive bond is as follows: A dismountable brass frame $\frac{1}{4}$ in. deep is placed on a sample of the backing material. The plaster mix being tested is fed into this frame, surplus material is screened off to give a flat surface to the plaster. The size of the brass frame is a matter of choice and convenience. The entire test assembly, after preparation, is placed in a humid room overnight, then removed to be conditioned to constant weight, and tested.

In testing a plastered panel, disks of plaster 2 in. in diameter are isolated from the body of the sheet with a suitable fly-cutting device. Although the design of the fly-cutter may vary widely,

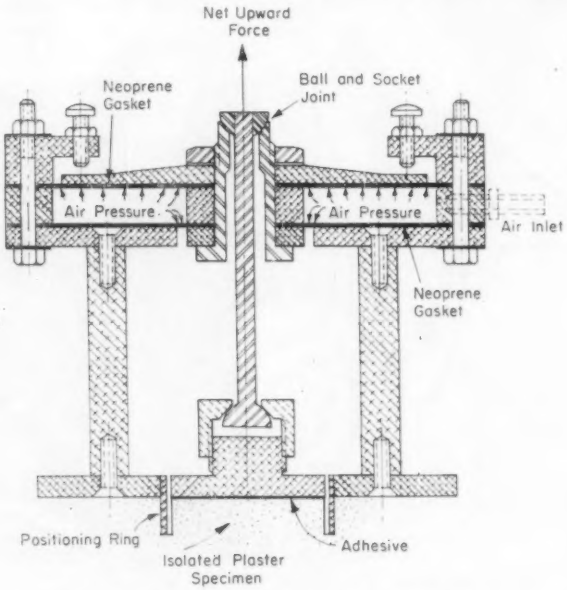

Fig. 1—Section through adhesion testing device.

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* This is a contribution from the Division of Building Research, National Research Council, Canada, and is published with the approval of the Director of the Division.

[1] J. F. Ryder, "Methods for Testing the Adhesion of Plaster to Concrete," *Chemistry and Industry*, Aug. 10, 1957, pp. 1090–2. V. Saretok, "Puts och Putsning" (Plastering and Rendering), Translated from the Swedish, *RILEM Bulletin No. 39*, pp. 5–79 (1957).

[2] J. C. P. Peter, "Adhesion of Gypsum Plaster to Various Backgrounds," *The American Architect*, Vol. 128, Sept. 9, 1925, pp. 227–234.

[3] Minneapolis-Honeywell No. 356529-1.

B. M. O'KELLY was a member of the Division of Building Research of the National Research Council of Canada from 1952 until 1960. During that time his work was concerned with plastering materials; he also took an active part in the work of ASTM Committees C-7 on Lime and C-11 on Gypsum. Prior to 1952, Mr. O'Kelly was employed for two years as quality control chemist in a gypsum plant in Ireland. In 1960 he left the Division to join the U.S. Gypsum Company in Chicago as a research chemist.

it must be possible to feed the cutter slowly into the plaster, otherwise an irregular groove will almost certainly result.

Using a suitable contact adhesive,[4] an aluminum disk carrying a threaded stud is cemented to the isolated plaster disk. A short thin-walled aluminum

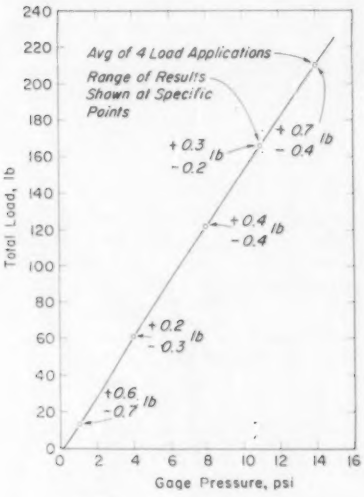

Fig. 2.—Calibration curve.

positioning ring is inserted into the groove made by the fly-cutter in the plaster, and the base of the adhesion testing device is fitted around it (see Fig. 1). This technique insures centering of the testing device over the test specimen. The testing device is screwed to the threaded stud. Air pressure is then increased until failure occurs. A manual-loading pressure regulator insures that the pressure registered on the pressure gage after failure of the specimen is the pressure at failure, irrespective of the fact that, on failure, a change in volume occurs in the pressure cell of the testing device.

[4] Minnesota Mining and Manufacturing Co. 3M Adhesive EG524 has been found satisfactory for this purpose.

TABLE I.—RESULTS OF ADHESION TESTS.

Plaster Base	Not Vibrated				Vibrated			
	Failure Load, psi			Number of Disks Tested	Failure Load, psi			Number of Disks Tested
	Max	Min	Avg		Max	Min	Avg	
Gypsum lath, groove cut through lath paper[a]	19.1	11.8	15.2	6	..	..	..	..
Gypsum lath, groove not cut through lath paper[a]	22.3	17.9	20.3	7	..	..	..	..
Corkboard	11.7	10.3	10.8	6	11.1	10.6	10.7	7
Various brands of bead-type foamed polystyrene:								
Brand "A," first test[a]	13.9	10.7	11.6	9	..	..	..	..
Brand "A," second test[b]	13.8	12.1	13.2	14	14.1	11.8	12.9	15
Brand "B," first test[a]	13.9	10.7	12.1	12	..	..	..	..
Brand "B," second test[b]	13.0	11.5	12.3	14	13.5	12.1	12.8	15
Foamed polystyrene, other than bead-type:								
One brand[b]	19.3	13.0	15.7	30	17.9	13.1	15.4	29

[a] First plaster batch.
[b] Second plaster batch.

Fig. 3.—Pressure regulator, pressure gage, and adhesion device.

Summary

The results of some adhesion tests are given in Table I. Plaster-to-water ratio in all cases was 2 to 1; unaggregated hardwall plaster was used throughout. All panels were conditioned at 70 F and 100 per cent relative humidity and then dried at 70 F and 50 per cent relative humidity.

These results are of interest mainly to show the reproducibility. The interpretation of them is somewhat more difficult, particularly in the test on gypsum lath since the breaks were not consistently at the plaster lath interface. In the case of the polystyrene bases the majority of failures occurred by separation of the plaster to base interface, but in a number of cases separation occurred partly or largely in the base itself. The true bond strength can never be less than but may exceed the value shown.

Before testing, some panels were clamped to a Gilson sieving machine and vibrated for 15 min. This test procedure has the important advantage that a large number of adhesion determinations can be made from a comparatively small test panel. For example, from a sheet of plaster 9½ in. square it is possible to isolate sixteen 2-in. diameter test disks.

A study involving the determination of the bond of plaster applied to a 12-ft-high ceiling has demonstrated that field testing of plaster bond is practicable when using the apparatus that has been described.

The Permeability of Sand Stabilized with a Chemical Grout

By G. H. DORION, H. BURKHARD, and M. L. WHITE

IN THE DEVELOPMENT of AM-9[1] chemical grout it became of interest to measure the water permeability of a grouted sand to get an indication of the general effectiveness of this grout in rendering soils impermeable. The results of experiments designed to measure the Darcy coefficient of permeability for sand treated with AM-9 are given here.

AM-9 is an aqueous solution of monomers which can be polymerized to a stiff gel after addition of a catalyst. In practice, the aqueous solution is injected into a soil mass or other formation through which water can flow. After a predetermined period of time the solution solidifies to a continuous gel and seals the voids in the soil mass. A quantitative value of the impermeability of the grouted soil was not available, although the mechanical behavior of soils treated with AM-9 has been discussed (1).[2] Successful field applications of this chemical grout have been previously reported (2).

A permeameter designed to measure the low permeabilities that would be expected in chemically grouted soils was constructed (Fig. 1). This permeameter, in essence allowed relatively high pressures (125 psi) of nitrogen to force water through various sizes of specimens. The permeameter was flexible to the extent that: (1) the specimen containers could be varied in length $\frac{3}{4}$, 1, or 2 in., (2) the water pressure could be changed, and (3) if needed, the cross-sectional area of the specimen could be varied.

Specimens were prepared by a standard method. The container to be used was first removed from the permeameter. In a separate vessel, a volume of washed, narrowly graded, medium sand greater than that of the specimen container was saturated with a given concentration of AM-9 grout. The gel time chosen for the AM-9 solution was about 15 min. The saturated sand was poured into the specimen container,

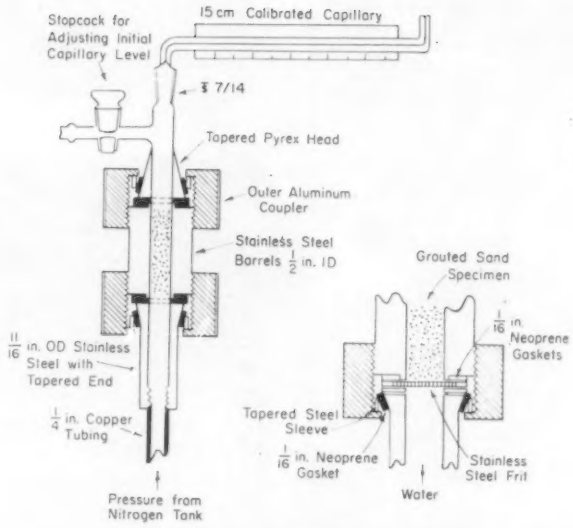

Fig. 1.—Permeameter apparatus.

G. H. DORION, research chemist, has conducted research on potential chemical modifiers for soils. An organic chemist in the Applied Research Dept. of the Central Research Div., American Cyanamid Co., his interests have included new monomer and catalyst systems for polymeric gel formation.

H. BURKHARD, technical assistant, has been associated with the Central Research Div., American Cyanamid Co. since 1958. He has been principally engaged in the development and testing of polymeric materials that can alter the engineering properties of soils.

M. L. WHITE, research chemist, is a physical chemist whose main interest in the Applied Research Dept., Central Research Div., has been in developing procedures to study the fundamental properties of gel systems. Prior to 1959, he was an investigator with the New Jersey Zinc Co.

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[1] Trademark of American Cyanamid Co.
[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

one end of which was sealed, and mechanically vibrated to maximum density. After the specimen had gelled, the excess stabilized sand was trimmed off to give a specimen of standard length and cross-sectional area. The specimen container was then replaced in the permeameter. Measurements were made by forcing water under nitrogen pressure through the specimen and noting the flow through the calibrated capillary at a known temperature. The specific permeability could be calculated from the following equation (3):

$$K = \frac{V\eta L}{At(p_1 - p_2)} \quad \ldots\ldots (1)$$

K = specific permeability, sq cm,
V = volume of flow in time, t, cu cm,
L = length of flow path, cm,
A = cross-sectional area through which flow is occurring, sq cm,
t = time, sec,
p_1 = pressure at the high-pressure end of the specimen, dynes per sq cm,
p_2 = pressure at the low-pressure end of the specimen, dynes per sq cm, and
η = viscosity of water, poises.

Since p_1 is much greater than p_2, Eq 1 reduces to

$$K = \frac{V\eta L}{AtP} \quad \ldots\ldots (2)$$

where:

$P = p_1$.

Now, the Darcy coefficient of permeability, k, is given by the following expression (4):

$$k = \frac{QL}{hA} = \frac{VL}{hAt} \quad \ldots\ldots (3)$$

where:

Q = volume flow of water = V/t, cu cm per sec,
h = pressure head, cm,

and the other terms are the same as in Eq 1.

One can obtain k from K by dividing Eq 3 by Eq 2, giving:

$$k = K\frac{P}{(\eta h)} = K\,(1.1)10^6 \quad \text{(cm per sec at 25 C)} \quad (4)$$

In our experiments, we measured K and converted to k by Eq 4. Table I summarizes the data obtained. The reproducibility of the permeability measurements, as indicated by the standard deviations and number of tests, was good. Attempts to obtain Darcy coefficients for the grouted sand were unsuccessful when a conventional variable head permeameter, described elsewhere, was used (5).

TABLE I.—DARCY COEFFICIENT OF PERMEABILITY, CM PER SEC.

Material	Mean Value	Standard Deviation	Number of Tests
Jersey sand	2.3×10^{-3}	0.6×10^{-3}	3
Keyport silt clay	80×10^{-9}	4×10^{-9}	12
Jersey sand treated with 5 per cent AM-9 chemical grout	3.3×10^{-9}	0.5×10^{-9}	22
Jersey sand treated with 10 per cent AM-9 chemical grout	0.36×10^{-9}	0.02×10^{-9}	20

TABLE II.—COEFFICIENTS OF PERMEABILITY FOR GEL AND FOR SAND TREATED WITH AM-9, CM PER SEC.

Specimen	Gel	Gel plus Sand
AM-9 grout, 5 per cent	$(0.42 \pm 0.02)\ (10)^{-9}$	$(3.3 \pm 0.5)\ (10)^{-6}$
AM-9 grout, 10 per cent	$(0.20 \pm 0.01)\ (10)^{-9}$	$(0.36 \pm 0.02)\ (10)^{-9}$

Table I indicates that sand treated with a chemical grout is a million times less permeable than the ungrouted sand, and is about a hundred times less permeable than a Keyport silt clay as measured by our permeameter. The results also indicate that the 5 per cent chemical grout is adequate to render the sand highly impermeable.

A concluding experiment measured the permeability of the AM-9 gel. This was performed on a permeameter similar in design to that shown in Fig. 1, except that the specimen holder was made smaller to accommodate thin gel specimens (6). Table II presents the gel data together with those for the sand treated with AM-9. Standard deviations of the mean are included. A direct comparison between the permeabilities of the two systems is difficult to interpret, since in the grouted sands one is actually measuring the permeability through a heterogeneous sand-plus-gel mass, while in the gel measurements only gel is present. However, it is interesting to note that the permeabilities obtained from measurements of both systems are of the same order of magnitude.

Summary

In summary, it is felt that the permeameter described in this paper presents a relatively simple method for the determination of the permeability of highly impermeable materials, which should be useful to workers in this field.

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(1) R. L. Schiffman and C. R. Wilson, "The Mechanical Behavior of Chemically Treated Granular Soils," *Proceedings*, Am. Soc. Testing Mats., Vol. 58, p. 1218, (1958).
(2) See, for example, L. Bilheimer, "Chemical Grout Technique Solves Meramec Shaft Sinking Problem," *Engineering and Mining Journal*, Vol. 160, p. 107, Nov., 1959.
(3) R. M. Barrer, *Diffusion In and Through Solids*, Macmillan Co., New York, N. Y. (1941), p. 60.
(4) D. W. Taylor, *Fundamentals of Soil Mechanics*, John Wiley & Sons, Inc., New York, N. Y. (1958), Chapter 6.
(5) T. W. Lambe, "The Permeability of Compacted Fine-Grained Soils," Symposium on Permeability of Soils, Am. Soc. Testing Mats., p. 56, (1954). (Issued as separate publication ASTM *STP No. 163*.)
(6) M. L. White, *Journal of Physical Chemistry*, in press.

A More Sensitive Method for Dielectric Strength of Insulating Oil

By P. F. AST

A proposed new test method for determining the dielectric strength of transformer oil has been evaluated by Subcommittee N on Electrical Tests of Committee D-27 on Electrical Insulating Liquids and Gases. Sixteen laboratories participated in a round-robin investigation to compare the sensitivity of the new test method with that of the present standard method of test, D 877–49.[1] It was shown that the new test method, which features spherically capped electrodes, mild circulation, and multiple breakdowns on a single, 1-qt sample, is more sensitive than Method D 877 to changes in oil quality that affect the dielectric strength of oil. The new test method has therefore been recommended by Subcommittee N as an alternative method of test for determining the dielectric strength of insulating fluids.

LAST year Committee D-27 on Electrical Insulating Liquids and Gases completed a 2-yr investigation of a proposed new test method for determining the dielectric strength of transformer oil. The new test method had been submitted for consideration (1,2)[2] as being more sensitive to oil quality, and more responsive to changes in oil quality caused by the presence of contaminants, than the existing standard test method, D 877–49.[1] The purpose of the investigation was to compare the sensitivity of the new test method with that of D 877.

Need for a More Sensitive Test

The need for a more sensitive dielectric-strength test resulted from the trend toward reduced insulation levels in high-voltage, oil-filled transformers. As these insulation levels are reduced, the 60-cycle test voltage is also reduced and more closely approaches the maximum operating voltage of the transformer. If one assumes a continuation of this trend in the future, it is apparent that the steady-state dielectric strength of the oil may become the limiting factor in selecting insulation levels in oil-filled transformers. For this reason it is essential that modern high-voltage apparatus be filled with oil of known high quality, essentially free of contaminants which could impair its dielectric strength. Furthermore, in order that full advantage of this higher dielectric strength may be obtained, it is equally essential that a suitable method be available for evaluating the improved quality of the oil.

The results of the Committee D-27 round-robin investigation, which are summarized in this paper, clearly indicate that the proposed new test method is more sensitive than the existing method, and that the latter does not adequately detect the improvement in dielectric strength of oil when contaminants are minimized. For this reason the subcommittee has recommended to Committee D 27 that the new method be adopted as an alternative method of test for determining the dielectric strength of insulating fluids.

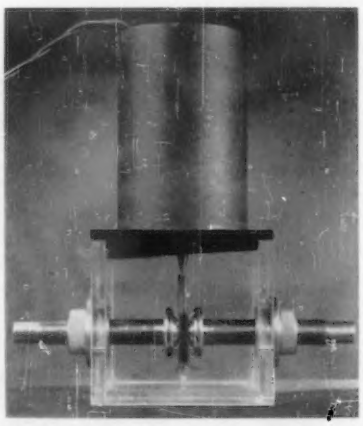

Fig. 1.—Dielectric strength test cell with spherically capped (VDE) electrodes.

Description of New Test Method

The new test method uses a pair of spherically capped electrodes of the VDE-type[3] mounted horizontally in an approximately cubical container of slightly less than 1-qt capacity. The electrodes are 0.081 in. apart. A small impeller driven by a motor mounted on the cover of the test cell circulates the oil during the test (Fig. 1).

Six breakdowns are obtained on a single filling of the test cell, using 60-cycle voltage increased from zero at a rate of ½ kv per sec. The first breakdown is discarded, and the last five are averaged to obtain the mean breakdown voltage of the sample.

Further details and discussion of the new test method are given in the Appendix.

Description of Round-Robin Investigation

The usual method of circulating one set of oil samples to all 16 participants could not be used. It would not only have been impossible to prepare a large number of samples of uniform quality, but it would have been equally impossible to assure that the oil quality remained unchanged from the time of preparation to the time of testing. Therefore, each participant was provided with one of six identical test cells of the new design, and asked to prepare his own set of oil samples, varying the oil quality by introducing moisture and other contaminants into oil that had been previously dried and filtered. Identical oil samples were to be tested in the new test cell according to the

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[1] ASTM Method of Test for Dielectric Strength of Insulating Oil of Petroleum Origin, 1958 Book of ASTM Standards, Part 7, p. 366; Part 9, p. 876.

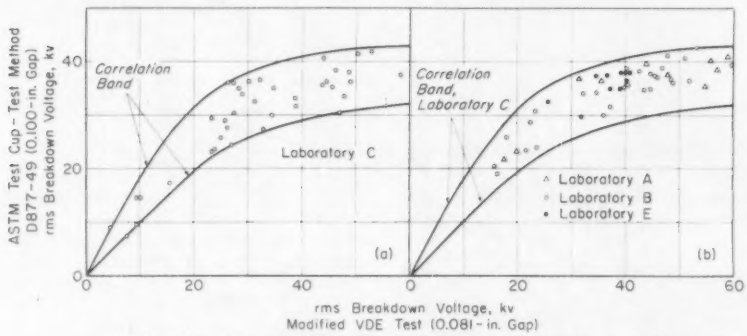
[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Verein Deutscher Elektrotechniker (Specification 0370)

P. F. AST has been a member of the Electrical Research Component of the High Voltage Laboratory, General Electric Co., for the past 13 years. A major activity during this period has been the study of breakdown phenomena in liquid and gaseous dielectrics. Prior work included 3½ years at Underwriters' Laboratories, Inc., and 5 years at the Laboratory for Insulation Research, Massachusetts Institute of Technology.

recommended procedure, and also in the ASTM test cup according to Method D 877. Each participant used his own ASTM test cup. The 1-qt cell used in the proposed test method was returned to the coordinating laboratory after each use, where it was cleaned and the electrodes repolished to their original condition before being sent on to the next participant.

instead tested an available variety of new and used oils. Others varied oil quality by filtration, deaeration, and humidification techniques, by adding contaminants such as alcohol and asphaltic compounds, or by mixing new oil with badly contaminated "junk" oil. Two of the laboratories used replications, the others did not.



(*a*) Data for laboratory C. (*b*) Data for laboratories A, B and E.

Fig. 2.—Relationship between breakdown voltages of transformer oil as determined by ASTM Method D 877 (0.100-in. gap) and modified VDE test method (0.081-in. gap).

Results of the Round-Robin Investigation

Test data obtained by the various participants were collected and analyzed by the author, and presented in a unified report (3) to Subcommittee N of Committee D-27. Because of space limitations, only a few representative sets of data can be presented in this paper, and these only in graphical form. For those who wish to study the complete data, two copies of the original report (3) have been filed for reference at ASTM Headquarters.

No two laboratories conducted identical investigations. Although most of the participants followed the suggested procedure, they did so in varying degrees. The number of oil samples tested varied from four to 38. Some laboratories made no attempt to vary oil quality in a controlled manner, but

Several of the participants obtained breakdown data in the new test cell for an electrode spacing of 0.040 in., as well as for the originally proposed spacing of 0.081 in. The 0.040-in. spacing was of interest because many of the oil test sets now in use, especially those used in the field, have a maximum voltage output of only 30 or 35 kv. With such a limitation in available test voltage, a reduced electrode spacing is necessary if the dielectric strength test is to be capable of truly indicating the relative quality of the oil being tested rather than serving merely as a "go, no-go" gage of oil quality.

Several laboratories also conducted side investigations to explore additional areas of interest in the present ASTM test. One such investigation was made to obtain comparative data in the ASTM cup for five breakdowns on a single cup filling versus single breakdowns on each of five separate cup fillings. Another was made to evaluate the effect of discarding the first of six breakdowns on a single cup filling for tests made in the ASTM cup. The interested reader will find these tests reported in detail in the Subcommittee N round-robin report (3).

In the following discussion, the proposed new test method will be referred to, for convenience, as the modified VDE test. When the discussion relates to data obtained at a specific spacing of the spherically capped electrodes, this will be clearly indicated (for example, 0.081-in. modified VDE test).

ASTM Method D 877 Versus 0.081-in. Modified VDE Test

Eleven laboratories compared the modified VDE test at 0.081-in. electrode spacing with the ASTM test. The results obtained by four of these laboratories are shown in Figs. 2(*a*) and (*b*). The points in these graphs indicate the average breakdown voltages for each sample, determined as specified for the respective test methods.

Six of the participants obtained data that fell entirely within a correlation band which has been designated in these figures as the "laboratory C" correlation band. Considering the combined data from all participants, 131 out of a total of 147 oils tested (or 89 per cent) plotted within this correlation band. Of those that fell outside of the correlation band, several were subject to question. For example, one such point was for untreated oil from a transformer sump; this oil tested at the questionably high value of 32.8 kv in the ASTM cup, compared with a value of 10.8 kv in the 0.081-in. VDE gap. Seven of the "outside" points were from a group of 28 oils which had been tested by one of the participants in the ASTM cup by making five breakdowns on a single cup filling instead of single breakdowns on five separate cup fillings, the latter procedure being specified in Method

TABLE I.—VARIABILITY IN THE ASTM D 877 AND MODIFIED VDE DIELECTRIC STRENGTH TESTS ON TRANSFORMER OILS (DATA FROM LABORATORY A).

Treatment	Moisture Content, ppm	ASTM D 877 Breakdown Voltage,[a] kv							0.081-in. Modified VDE Test Breakdown Voltage,[a] kv						
		Sample Number					Grand Average	Standard Deviation	Sample Number					Grand Average	Standard Deviation
		$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	$\bar{X}_5$			$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$	$\bar{X}_5$		
New Oil															
As Received	22	39.4	36.7	37.1	37.7	37.3	37.64	3.70	48.0	46.6	47.0	49.4	47.0	47.60	4.12
Humidified	39	39.2	37.8	40.2	31.8	35.1	36.82	6.38	31.0	27.8	29.4	33.0	36.2	31.48	4.92
Humidified	55	22.4	22.8	20.4	22.1	21.7	21.88	3.42	12.4	19.3	18.1	21.1	16.7	17.64	4.74
Deaerated	27	38.4	38.7	39.5	36.6	40.0	38.64	4.16	56.6	58.0	56.4	57.4	55.8	56.84	2.80
Filtered and Deaerated	22	38.1	42.9	40.4	40.9	42.6	40.98	3.80	57.4	58.0	59.4	59.6	58.8	58.64	1.44
Used Oil															
As Received	33	35.6	37.9	40.5	40.3	44.7	39.80	4.94	47.0	43.6	42.3	43.4	42.0	43.66	4.42
Humidified	43	34.6	35.1	37.9	35.1	39.1	36.36	3.52	31.9	34.7	38.1	36.5	...	35.30	3.98
Humidified	60	22.2	23.5	20.7	23.1	25.8	23.06	4.77	18.7	20.1	19.1	22.9	18.5	19.86	3.35
Deaerated	26	32.6	35.1	36.2	34.0	39.3	35.44	4.21	54.4	54.0	55.4	51.8	58.2	54.76	4.11
Filtered and Deaerated	24	38.3	42.7	39.7	43.3	36.6	40.12	5.60	54.0	57.6	55.0	55.6	55.0	55.44	3.65

[a] Sixty-cycle, rms.

D 877. Data from this laboratory could be represented by a correlation band similar to that shown in Figs. 2(*a*) and (*b*), but with a slightly higher upper limit.

Inasmuch as almost 90 per cent of the total data falls within the laboratory C correlation band, it is reasonable to use this band as a basis for comparison of the two dielectric strength test methods. The width of the band is, of course, determined by the variability in the two tests, the major source of the variability probably being in the sample itself. This variability is illustrated in Table I, for data obtained by laboratory A. This laboratory tested ten oils of different quality, in a carefully controlled investigation, using five replications in both the ASTM and 0.081-in. modified VDE tests. Even though extreme precautions were taken to ensure uniformity in the test samples from a given batch of oil, considerable variability will be noted in the average breakdown voltage of the individual samples, in both test methods. It will also be noted that the standard deviation in breakdown voltage is about the same for both test methods.

In order to compare the sensitivities of the two test methods, it is therefore appropriate to examine the shape of the correlation band. When this is done, it is evident from the pronounced curvature of the band that the 0.081-in. modified VDE test is much more sensitive than the present ASTM test in assessing the dielectric strength of an oil. The greater sensitivity of the modified VDE test becomes even more apparent if the data are plotted in terms of dielectric strength (breakdown voltage divided by electrode spacing).

ASTM Method D 877 Versus 0.040-in. Modified VDE Test

Tests to compare the modified VDE test at 0.040-in. electrode spacing with the ASTM test were made by eight laboratories. Results obtained by two of these laboratories are plotted in Fig. 3, which shows the data plotted both in terms of breakdown voltage and breakdown strength. The correlation band shown in Fig. 3 includes 88.5 per cent of the data from all eight participants (84 out of 95 values); the data plotted in Fig. 3 could obviously be represented by a much narrower band.

The comparison of the two test methods provided by Fig. 3, and comparison of the 0.040- and 0.081-in. modified VDE data (not shown here but presented in the Subcommittee N round-robin report (3)) indicate that although the 0.040-in. modified VDE test is more sensitive than the ASTM test in evaluating the dielectric strength of an oil, the 0.040-in. VDE gap is somewhat less sensitive than the 0.081-in. gap for higher strength oils.

ASTM Method Versus Modified VDE Test—Sensitivity to Moisture

In a very carefully controlled experiment, laboratory A evaluated the relative sensitivities of the ASTM and modified VDE tests to moisture in new and used oil. The results are plotted in Fig. 4.

moisture contents investigated. For moisture contents above 45 ppm, the ASTM test had approximately the same sensitivity as the 0.081-in. VDE test.

The 0.040-in. modified VDE test also showed a high sensitivity to moisture. For used oil the breakdown voltage decreased linearly with increasing moisture content. Although the slope of the breakdown voltage

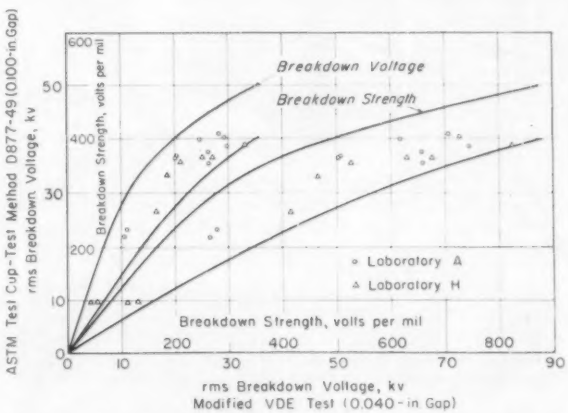


Fig. 3.—Relationship between breakdown voltages of transformer oil as determined by ASTM Method D 877 (0.100-in. gap) and modified VDE test method (0.040-in. gap).

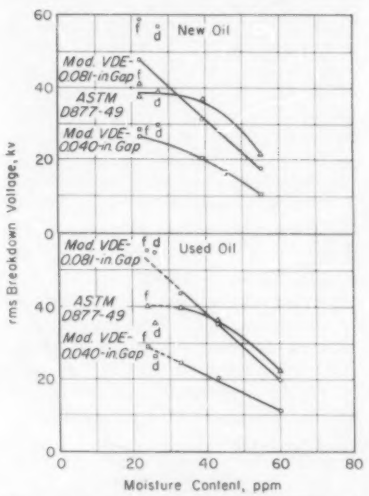


Fig. 4.—Sensitivities of the ASTM and modified VDE test methods to absorbed moisture in transformer oil.

The plotted points are for the oil "as received" and after humidification, except that points marked "d" are for the oil after deaeration, and points marked "f" are for the oil after filtration and deaeration. Data are from laboratory A.

For both the new and used oil, the ASTM test was insensitive to moisture in concentrations up to about 30 or 35 ppm (about 60 per cent of saturation at room temperature). The 0.081-in. modified VDE test showed the greatest sensitivity to moisture, the decrease in breakdown voltage being linear with increasing moisture over the range of

versus moisture content curve for the 0.040-in. gap is only 0.5, compared with a slope of 0.9 for the 0.081-in. gap, if the data are plotted on a volts-per-inch breakdown strength basis the slopes would become 12.5 versus 11.1, which means that the 0.040-in. gap is even more sensitive to moisture than the 0.081-in. gap, for used oil.

For new oil, the data from laboratory A indicate that the 0.040-in. gap may be slightly less sensitive to changes in moisture content at the low end of the range than at the upper end. Compared with the ASTM test, however, the 0.040-in. modified VDE test shows a significantly higher sensitivity to changes in moisture content in the range below about 60 per cent saturation.

Conclusion

The proposed new (modified VDE) test method is considerably more sensitive than the present ASTM standard method of test (D 877) in depicting the dielectric strength of insulating oil. The new test method is clearly more responsive to changes in oil quality. When the contaminant is absorbed moisture, the present method (D 877) shows no change in dielectric strength for moisture contents up to approximately 60 per cent saturation. The modified VDE test, on the other hand, shows a pronounced, linear decrease in dielectric strength with increasing moisture content of the oil.

Acknowledgment:

The original investigation that led to the development of the modified VDE test described in this paper was initiated by Mr. K. H. Weber, presently with the Lamp Engineering Research Laboratory of the General Electric Co. The author is also pleased to acknowledge Mr. Weber's contribution of the explanation for the effects of circulation and rate of rise on breakdown voltage, and the contributions of those members of Subcommittee N who participated in the Committee D-27 round-robin investigation.

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APPENDIX

Various Features of the Proposed New Test Method

Electrodes

The spherically capped electrodes used in this test are designed according to the German Standard VDE Specifications 0370. The dimensions are shown in Fig. 5. The main purpose in selecting this configuration in preference to other uniform-field electrode configurations that would be equally sensitive to changes in oil quality, such as Rogowski electrodes, is that the VDE configuration is a well-established standard. Small-diameter spheres (½ in. or less) are also standard configurations in five European countries, but it was felt that electrodes of this small size were susceptible to alignment difficulties because of their small-diameter shafts.

Test Cell—Circulation Effects

The test cell has a beveled cover, which assures a completely oil-filled container and removes from circulation any small gas bubbles that may occasionally be present. The motor-driven impeller provides mild circulation of the oil. This assures that a representative oil sample will be tested by the electrodes, prevents the settling out of contaminants, and removes breakdown products from the gap. The effects of circulation are shown in Fig. 6. Note that circulation lowers the mean breakdown voltage of the oil.

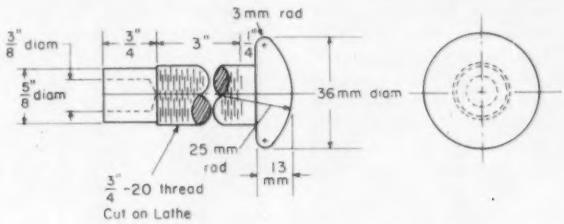

Fig. 5.—Spherically capped (VDE) electrode.

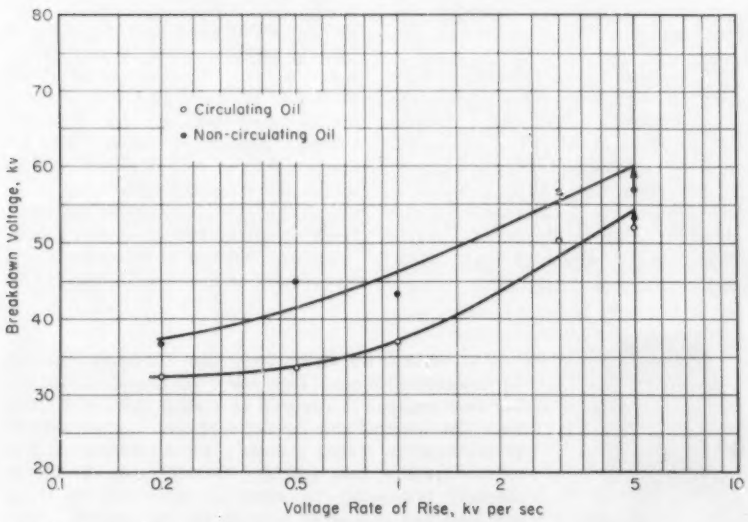

Fig. 6.—Effects of circulation and rate of voltage rise on breakdown voltage of transformer oil in the new test cell (0.081-in. gap).

The reduction in breakdown voltage caused by circulation may be readily explained on a "weak-link" basis. If it is assumed that the oil in the test cell consists of a large number of "unit volumes" of small size, and that these "unit volumes" have a statistical distribution of breakdown voltage due to inhomogeneity of moisture content or solid contaminants, the breakdown voltage of the oil between the electrodes in any given test is determined by the breakdown voltage of the weakest "unit volume" between the electrodes. For circulating oil, it is apparent that a larger number of "unit volumes" flow through the gap during a unit time. Therefore, if the rate of rise is not excessively high, it is obvious that circulation increases the probability that a "unit volume" of oil of less than mean breakdown strength will be present in the gap during any given time. Thus, for circulating oil, one would expect the mean, maximum, and minimum values of breakdown voltage in a number of tests to be lower than the corresponding values for a similar number of tests in the same oil sample without circulation.

Rate of Rise

The proposed test method increases voltage at the rate of ½ kv per sec, primarily because this rate more nearly resembles the usual 1-min high-potential test on transformers than does the 3 kv per sec rate of rise specified in Method D 877. The effect of rate of rise on breakdown voltage is shown in Fig. 6.

The increase in breakdown voltage with increasing rate of rise may be explained on the basis of the "unit volume" model previously postulated. It is apparent that for a given rate of flow through the gap, the effect of an increase in rate of rise of voltage is to decrease the volume of oil that is stressed at a given voltage level. This decreases the probability that "unit volumes" of low breakdown strength will be present in the gap during any given time, or, conversely, increases the probability that only the more abundant "unit volumes" whose strengths are closer to the mean (or modal) value will be present in the gap during the time of voltage application. One would therefore expect higher rates of rise to result in higher values of gap breakdown voltage.

Predicting Weatherability of Coating Grade Asphalts from Asphaltene Characteristics*

By E. W. MERTENS

The Weather-Ometer durability of a coating grade asphalt derived from an unfluxed, uncatalyzed residuum of a crude oil or a blend of crude oils can be predicted from the dispersibility of the asphaltenes of the asphalt. This correlation was excellent for 10 of the 11 asphalts examined in this study.

The dispersibility of the asphaltenes is measured by titrating a xylene solution of the coating grade asphalt with *n*-heptane. The experimental procedure and the method of calculation are given.

This property is related to a fundamental property of the least soluble asphaltenes, their solubility parameter. Thus, this work offers not only a quick method for estimating asphalt weatherability, but also it relates weatherability to a fundamental property of asphalt.

A RAPID METHOD for estimating the durability of asphalts used for roofing has been a basic need for both the asphalt and the asphalt roofing industries. In recent years, Weather-Ometers have been used extensively for this purpose because asphalts degrade much more rapidly under Weather-Ometer conditions than they do when exposed to the weather. Although Weather-Ometer results have not been quantitatively correlated with outdoor weathering results, nevertheless, they are used successfully as a guide to differentiate among asphalts and to select asphalts for durable roofing products.

By the use of Weather-Ometers, an estimate of the relative durability of two or more asphalts can be obtained within a few months. Under actual service conditions, however, this information cannot be derived until the products have been exposed at least several years. Thus, the substantial reduction in time afforded by Weather-Ometers to obtain such an estimate has proved to be advantageous.

However, even the comparatively short time of a few months required to obtain durability data by Weather-Ometer methods is much too long for many types of asphalt weathering research. For this reason, a study was undertaken to develop a quicker method for predicting asphalt weatherability. A second objective of this work was to relate weatherability with a fundamental property of the asphalt.

This paper presents the results of this preliminary work. On a limited number of coating grade asphalts, a good correlation has been established between the Weather-Ometer life of the asphalt and the dispersibility characteristics of the least soluble asphaltenes from the air-blown, unweathered asphalt. The method for determining these characteristics is simple, requires little time, and is economical.

Asphalt Description and Conventional Properties

Eleven different coating grade asphalts were used in this study, each derived from a different crude oil. The crude oils include production from such major producing areas throughout the world as the South American, Mid-East, Mid-Continent, and California fields. Eight of the asphalts were obtained simply by air-blowing a residuum from a given crude oil to a coating grade product. The remaining three asphalts were produced by air-blowing a blend of residua from two crude oils to coating grade. None of the products was catalyzed (for example, with ferric chloride or phosphorus pentoxide), nor were any of the products blown with a fluxing oil. The conventional properties of these asphalts are summarized in Table I.

All asphalts were laboratory air-blown. The capacity of the equipment is approximately 1 gal. All products were air-blown at 475 F. The charge was under constant agitation throughout the air-blowing operation by means of a mechanical stirrer. The finished products were poured into several quart friction-top cans and kept closed until tested.

The Weather-Ometer data, shown in Table I, were obtained under carefully controlled conditions. The panels for Weather-Ometer exposure were made by the hydraulic press method (1),[1] except that Teflon was used instead of dextrin-coated paper. Immediately prior to making the panels, the asphalt was melted in a double boiler-type container to prevent any local overheating. All panels were exposed in model DMC, single-arc Weather-Ometers[2] within 24 hr of their preparation.

Twelve panels of each asphalt were made. Four panels of each asphalt were placed in each of three Weather-Ometers. The confidence interval at the 95 per cent confidence level for the durability of the asphalt is approximately ± 9 per cent of the value reported in Table I (2).

Once placed in the Weather-Ometers, the panels were exposed to a cycle consisting of 51 min of dry light from the carbon arcs followed by 9 min of simultaneous exposure to light and chilled water spray. This cycle, identified as the 51-9C cycle (3)[3] was repeated for 22 hr of each day the Weather-Ometers were in operation. The remaining 2 hr of each day were used to service the Weather-Ometers and to inspect the panels. The panels and panel holders were inverted on alternate days.

The salt content of the spray water was reduced to less than 20 ppm. This

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* Presented at ASTM Committee Week Meeting, Chicago, Feb. 1–5, 1960.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Manufactured by the Atlas Electric Devices Co., Chicago, Ill.

[3] Tentative Recommended Practice for Accelerated Weathering of Bituminous Materials (D 529 – 59 T), 1959 Supplement to Book of ASTM Standards, Part 4, p. 150.

E. W. MERTENS, Group Supervisor, California Research Corporation, Richmond Laboratory, Richmond, California, has been engaged in research on asphalt since 1946. His work has involved the development and improvement of paving asphalts, roofing materials, asphalt emulsions, protective coatings, and specialty asphalt products. He is currently responsible for research and development on industrial and emulsified asphalts and for asphalt fundamental research.

was accomplished by the use of a deionizer. The temperature of the spray water was maintained at 40 ± 1 F. The water was delivered at the spray nozzles at 15 ± 3 psig.

Voltage regulators maintained the line voltage to the machines at 216 ± 2 v. The power consumption of the carbon arc lamps and solenoid coils, as measured by a watthour meter, was controlled within 1750 to 1850 w. With these controls, the voltage to the carbon arcs was kept within the range of 130 to 145 v, the current within the range of 15 to 17 amp, and the air temperature within the Weather-Ometer in the range of 140 to 145 F.

The high-voltage probe method (4) was used daily, 20 min after a spray period, to detect failure points in the asphalt film on a given panel. Panels containing breaks in the coating were spark photographed (5). The spark patterns were examined by placing a transparent grid of 60 squares covering the central 2 by 5-in. portion of the coating. The panel was considered failed when breaks occurred in at least 50 per cent of the squares.

Dispersibility of Least Soluble Asphaltenes

The dispersibility of the least soluble asphaltenes is measured in a hydrocarbon system of controlled solvency. This property was measured in a heptane-xylene solvent system by a procedure that is essentially a modification of the commonly used spot test or Oliensis test identified as AASHO Test T 102 – 42[4]. The detailed procedure to determine the dispersibility of the least soluble asphaltenes is given in the appendix.

Typical data obtained in testing asphalt G by this procedure are shown by

[4] Spot Test of Asphaltic Materials (AASHO T 102 – 42), *Highway Materials*, Am. Assn. of State Highway Officials, Part II, pp. 157–159 (1950).

[5] In the reference article, the authors define p_a by the equation

$$p_a = 1 - FR_{max}$$

where:

$$FR_{max} = \frac{V_X}{V_H + V_X}$$

Hence

$$p_a = 1 - \frac{V_X}{V_H + V_X}$$

Since

$$\frac{V_X}{V_H + V_X} + \frac{V_H}{V_H + V_X} = 1$$

then,

$$1 - \frac{V_X}{V_H + V_X} = \frac{V_H}{V_H + V_X}$$

Consequently,

$$p_a = 1 - \frac{V_X}{V_H + V_X} = \frac{V_H}{V_H + V_X}$$

TABLE I.—SUMMARY OF COATING GRADE ASPHALT PROPERTIES.

Asphalt	Softening Point, Ring-and-Ball Method, deg Fahr[a]	Penetration[b] at 32 F	Penetration[b] at 77 F	Penetration[b] at 115 F	Flash Point,[c] Cleveland Open Cup, deg Fahr	Weather-Ometer Life (51-9C [d] Cycle), days
A	223	13	18	25	460	22
B	217	12	20	37	505	28
C	221	11	18	32	530	44
D	220	11	16	30	535	46
E	220	9	16	27	490	49
F	213	12	18	31	560	56
G	220	10	16	34	455	65
H	215	12	17	30	490	72
I	225	15	21	33	610	72
J	213	9	16	32	480	89
K	217	12	19	32	615	89

[a] Standard Method of Test for Softening Point of Bituminous Materials (D 36 – 26), 1958 Book of ASTM Standards, Part 4.

[b] Standard Method of Test for Penetration of Bituminous Materials (D 5 – 52), 1958 Book of ASTM Standards, Part 4.

[c] Standard Method of Test for Flash and Fire Points by Cleveland Open Cup (D 92 – 52), 1958 Book of ASTM Standards, Part 4.

[d] Tentative Recommended Practice for Accelerated Weathering Test of Bituminous Materials (D 529 – 59 T), 1959 Supplement to Book of ASTM Standards, Part 4.

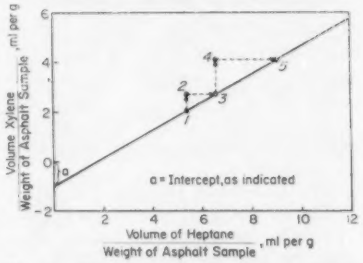


Fig. 1.—Typical plot of titration of an asphalt solution in xylene with heptane to determine asphaltene dispersibility.

the successive points *1*, *2*, *3*, *4*, and *5* in Fig. 1.

When the 10 ml xylene solution containing 5 g of asphalt G was first titrated with *n*-heptane, a positive spot did not occur until 27 ml had been added. This quantity represents a heptane volume to asphalt weight ratio of 5.4:1 as indicated by the abscissa value for point *1* in Fig. 1.

Upon the addition of xylene to this system which had been flocculated by the addition of heptane, the system remained flocculated as shown by the persistence of a positive spot until 4 ml of xylene had been added. At this point, the spot had become negative. As indicated by the ordinate value for point *2* in Fig. 1, the xylene volume to asphalt ratio is 2.7:1.

The system is next titrated with *n*-heptane until flocculation is again obtained, as shown in point *3*, at the heptane volume-asphalt weight ratio of 6.6:1. Upon the addition of xylene, the system remained flocculated, that is, continued to exhibit a positive spot, until the xylene volume-asphalt weight ratio of 4.1:1 was obtained, as shown by point *4*. The final step of obtaining a positive spot for the third time was the addition of *n*-heptane to the system until a heptane to asphalt ratio of 9.1:1 was reached, as shown by point *5*.

It will be noted in Fig. 1 that the points of flocculation, *1*, *3*, and *5*, lie along a straight line. Thus, the system above the line is homogeneous; whereas, below the line, the system is flocculated. Thus, at every point along this line, the solvency of the system is identical; that is, the line defines the critical solvency of the system that permits the least soluble asphaltenes to begin to flocculate.

In this series of steps to determine the several asphaltene flocculation points, a homogeneous system is titrated with a poor solvent until flocculation of the least soluble asphaltenes occurs. In this way, the amount of the poor solvent component in the total solvent needed to cause the least soluble asphaltenes to flocculate is a measure of the dispersibility of the least soluble asphaltenes. It follows that the more of the poor solvent needed to produce a flocculated system, the better is the dispersibility of the least soluble asphaltenes. Conversely, if the asphaltenes have poor dispersibility, only a relatively small amount of the poor solvent must be added before the system flocculates.

The dispersibility of the least soluble asphaltenes is defined as the volume fraction of the poor solvent in the total solvent system at infinite dilution according to the equation (6)[5]

$$p_a = \frac{V_H}{V_H + V_X}$$

where:

p_a = dispersibility of the least soluble asphaltenes,
V_H = volume of heptane in the solvent system, and
V_X = volume of xylene in the solvent system.

At infinite dilution, the dispersibility of the least soluble asphaltenes can be calculated directly from the above equation. However, this is not possible at the relatively small dilutions of the asphalt sample, as are obtained by the test procedure, because of the interference from the contribution of the

maltene phase to the solvency of the diluted system.

However, p_a can be calculated from the straight-line relationship shown in Fig. 1. The equation of the line is:

$$\frac{V_X}{A} = a + s\frac{V_H}{A}$$

where:

a = the intercept (shown in Fig. 1),
A = weight of the asphalt sample, and
s = the slope of the line.

or,

$$V_X = A_a + sV_H$$

Since, by definition,

$$p_a = \frac{V_H}{V_H + V_X}$$

at infinite dilution it follows that

$$1 - p_a = \frac{V_X}{V_H + V_X}$$

Thus, at infinite dilution

$$\frac{1 - p_a}{p_a} = \frac{V_X}{V_H}$$

From the equation of the line given above,

$$\frac{V_X}{V_H} = \frac{A_a}{V_H} + s$$

At infinite dilution $V_H \rightarrow \infty$, and, consequently, the term

$$\frac{A_a}{V_H} \rightarrow 0$$

therefore,

$$\frac{V_X}{V_H} = s$$

Since, as shown previously,

$$\frac{1 - p_a}{p_a} = \frac{V_X}{V_H}$$

then

$$\frac{1 - p_a}{p_a} = s$$

By rearranging the terms,

$$sp_a + p_a = 1$$

or

$$p_a = \frac{1}{1 + s}$$

The slope of the line in Fig. 1 is 0.56. Consequently, the dispersibility of the least soluble asphaltenes from asphalt G is determined as follows:

$$p_a = \frac{1}{1 + 0.56} = \frac{1}{1.56} = 0.64$$

The reproducibility of these data was very good. Identical data were obtained for duplicate samples of asphalt G run simultaneously. These data are shown in Table II as runs 1 and 1A for asphalt G. For replicate samples of several different asphalts run at different times and by different personnel, the reproducibility remained good. This is shown by typical data given in Table II for those asphalts which were tested two or more times in this manner.

TABLE II.—REPRODUCIBILITY OF ASPHALTENE DISPERSIBILITY DETERMINATION.

Asphalt	Run	Operator	Dispersibility of Asphaltenes, p_a
B....	No. 1	I	0.51
B....	No. 2	II	0.51
B....	No. 3	I	0.51
C....	No. 1	I	0.57
C....	No. 2	II	0.60
D....	No. 1	I	0.55
D....	No. 2	I	0.59
F....	No. 1	I	0.62
F....	No. 2	II	0.65
G....	No. 1[a]	I	0.64
	No. 1A[a]	I	0.64
G....	No. 2	II	0.62
I....	No. 1	I	0.71
I....	No. 2	II	0.71
I....	No. 3	I	0.68
J....	No. 1	I	0.53
J....	No. 2	II	0.55
K...	No. 1	I	0.79
K...	No. 2	I	0.79

[a] Run simultaneously by operator I.

The correlation between the dispersibility of the least soluble asphaltenes from the unweathered coating grade asphalts and the Weather-Ometer life of these asphalts is shown in Fig. 2. Of the eleven asphalts used in this study, the correlation holds well for all except asphalt J. This asphalt has an extraordinarily high durability in relation to the value derived for the dispersibility of its asphaltenes.

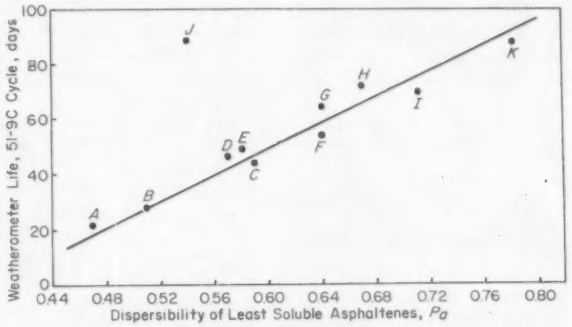


Fig. 2.—Durability of asphalt correlates with dispersibility of least soluble asphaltenes.

The reason for the abnormal behavior of asphalt J is unknown. Possibly the residuum was cracked slightly as it was being reduced from the crude oil or perhaps it was contaminated by highly carbonaceous materials either during transport of the crude oil, during the refining process, or in the laboratory air-blowing equipment. Another possible reason may be that residua from the crude oil may contain an unusually high concentration of carbenes and carboids, that is, components in the asphaltene fraction that are insoluble in carbon tetrachloride and carbon disulfide, respectively. As a fourth possibility, there may be some extraordinary influence of the maltene phase upon the dispersibility of the asphaltenes in asphalt J that does not exist in the other asphalts tested.

Nevertheless, with the exception of asphalt J, this correlation is remarkably good in view of the large experimental error inherent in determining Weather-Ometer durability (2) coupled with the experimental error in the determination of the dispersibility of asphaltenes. Despite these errors, measuring this property of asphaltenes of a coating-grade asphalt offers a promising method for estimating quickly the durability of the asphalt.

Relationship Between Dispersibility and Solubility Parameter

This property, dispersibility of the least soluble asphaltenes, can be related to a fundamental property defined as the solubility parameter of the asphaltenes.

In the absence of special effects, such as hydrogen bonding and ionic forces, mutual solubility of two or more components comprising a given system depends primarily upon the "internal pressure" or "cohesive energy density" of the the respective components (7). Hydrocarbons are comparatively free from these special effects; hence, this approach is particularly applicable to petroleum products work.

The cohesive energy density (or internal pressure) of a substance is called the solubility parameter. The more alike two substances are in this property, the more miscible they are.

According to the free energy equation

$$\Delta F_M = \Delta H_M - T\Delta S_M$$

the change in free energy on mixing is equal to the heat of mixing minus the product of temperature and the change in entropy. The more negative the free energy change is upon mixing, the greater is the likelihood that the system will be homogeneous. The entropy

change ΔS_M (the measure of disorder or randomness in a system) is always positive in the solution process. However, as the interaction term ΔH_M increases in a positive direction, a point will be reached where its contribution to be free energy change is predominant, and mixing will be incomplete. On the other hand, the smaller the ΔH_M term, the greater is the driving force that promotes homogeneity.

The heat of mixing is determined by the equation (**7**):

$$\Delta H_M = V_M \left[\left(\frac{\Delta E_1}{V_1} \right)^{1/2} - \left(\frac{\Delta E_2}{V_2} \right)^{1/2} \right]^2 \phi_1 \phi_2$$

where:

ΔH_M = over-all heat of mixing, cal,
V_M = total volume of the mixture, cu cm,
ΔE_1 and ΔE_2 = energy of vaporization per mole of components 1 and 2, respectively,
V_1 and V_2 = molar volume of components 1 and 2, respectively, and
ϕ_1 and ϕ_2 = volume fraction of components 1 and 2, respectively.

The expression $\Delta E/V$, sometimes called the internal pressure or cohesive energy density, is the energy of vaporization per cubic centimeter of a given component. The equation above shows that this term is important in determining heat effects. It is convenient to describe the square root of this term as the solubility parameter of the component and to assign to it the symbol δ. Thus, if δ_1 and δ_2 are the solubility parameters of the two components, then ΔH_M depends upon the value of $(\delta_1 - \delta_2)^2$. As $\delta_1 \rightarrow \delta_2$, then $(\delta_1 - \delta_2)^2 \rightarrow 0$. If, indeed, this quantity is 0, then solution is assured by the entropy factor (**8**).

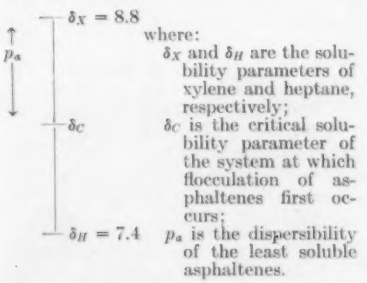
The solubility parameter of a substance may be determined by several different methods (**8**). Such methods include calculations based upon data from heat of vaporization, thermal coefficient, critical pressure, critical temperature, structural formula, surface tension, or pressure temperature data.

The work reported in this paper uses the method of mixed solvents to estimate the critical solubility of the solvent system at which flocculation of the least soluble asphaltenes begins. By using a good solvent (xylene) with a poor solvent (heptane), the solvency of the system and, hence, the solubility parameter of the solvent system, can be adjusted by varying the relative amounts of these components. Although xylene was chosen as the good solvent for these experiments, any solvent having nearly the same solubility parameter, such as toluene, benzene, or alpha-methyl naphthalene, could have been used in combination with any poor solvent having a low solubility parameter, such as hexane, octane, or cetane. However, the p_a value for a given asphalt will be different for each pair of solvents used in the system since, as will be shown below, the p_a value is a relative value determined by the solubility parameter of the components comprising the solvent system.

The solubility parameters of xylene and heptane are 8.8 and 7.4, respectively (**9**). Thus, as heptane is added to an asphalt solution in xylene, the solubility paramerer of the solvent system is gradually lowered until the system reaches a critical solubility parameter. At this point, the solvent system can no longer hold the asphaltenes in solution and flocculation results.

The critical solubility parameter at which the least soluble asphaltenes begin to flocculate may be calculated from the value determined for the dispersibility of the least soluble asphaltenes, p_a. This value, p_a, was defined as the maximum volume fraction of the poorer solvent that the system can contain at infinite dilution before flocculation of the least soluble asphaltenes occurs (**6**). Since the solubility parameters of xylene and heptane are 8.8 and 7.4, respectively, the critical solubility parameters at which flocculation occurs is at some intermediate value.

The relationship among these several quantities is shown graphically below:



where:
δ_X and δ_H are the solubility parameters of xylene and heptane, respectively;
δ_C is the critical solubility parameter of the system at which flocculation of asphaltenes first occurs;
p_a is the dispersibility of the least soluble asphaltenes.

Thus, algebraically, the critical solubility parameter of the system may be estimated as follows:

$$\delta_C = \delta_X - p_a(\delta_X - \delta_H)$$

As long as the solubility parameter of the system remains above the value of δ_C, the system is homogeneous. However, whenever this property falls below δ_C, a flocculated, two-phase system results.

In the case of asphalt G, the critical solubility parameter of the heptane-xylene system can be calculated by substituting the appropriate values in the above equation, as follows:

$\delta_C = 8.8 - 0.64\,(8.8 - 7.4)$,
$= 8.8 - 0.64$ by 1.4,
$= 8.8 - 0.9$, and
$= 7.9$.

A plot of the Weather-Ometer durability of these asphalts against the critical solubility parameter of the heptane-xylene solvent system, δ_C, is shown in Fig. 3. It will be noted that the lower the value of δ_C needed to flocculate the asphaltenes from a given coating grade asphalt, the better is the weatherability of the asphalt. As previously noted, asphalt J was the only asphalt that deviated markedly from this correlation.

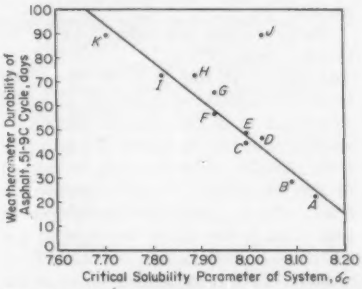


Fig. 3.—Correlation between durability of asphalt and critical solubility parameter of solvent system, δ_C.

It may be noted in Fig. 3 that the values of δ_C, the critical solubility parameter of the heptane-xylene solvent system required for each asphalt, are reported to three significant figures; whereas, the solubility parameters of the solvents are reported in the earlier discussion to only two significant figures. While the second decimal place is not significant in an absolute sense, it is significant on the relative scale defined by the heptane-xylene system. If the δ values of these solvents are assumed to be 7.40 and 8.80 instead of the normally reported 7.4 and 8.8 values, this permits the calculation of δ_C to the second decimal place. These assumptions are justified in a relative sense for, as shown in Fig. 3, the correlation is excellent when the δ_C value is calculated in this manner. Moreover as shown by the data in Table II, the data are reproducible. However, if the values of δ_C were calculated to their absolute significant value of one decimal place, the correlation would lose a substantial part of its accuracy in predicting weatherability.

Although this experimental method does not permit a direct calculation of the solubility parameter of the asphaltenes, this property can be estimated roughly. According to Hildebrand and Scott (**7**), a system comprised of a solvent and a hypothetical but typical high molecular weight polymer will be homogeneous if the solubility parameters of these components differ by

no more than 1.1. If asphaltenes can be considered similar to such a polymer, then the probable solubility parameter range for the asphaltene components from asphalt G lies within the interval of 7.9 to 9.0, as defined by the heptane-xylene solvent system.

Some Limitations of the Solubility Parameter Concept

In theory, the estimated value of δ_C is independent of the solvent pair used for the solvent system. However, in actual practice, some variation in the estimated value of δ_C is observed as one changes from a given solvent pair to another (8).

This variation has been observed by others working with asphaltic-type materials.[6] In this work, it was noted that the calculated value of δ_C varies somewhat from one solvent system to another, but the members of a group of such asphaltic materials will be ranked in the same order in all solvent systems. This is attributed to differences that exist in the molar volumes of the solvent components, specific interactions between the solvent system components themselves, and also specific interactions between components of the asphaltene fraction among each other and with either or both of the solvent system components.

Despite the fact that this method of estimating the critical solubility parameter of the asphaltene fraction is not as accurate as would be desired; nevertheless, a significant value of this work is the qualitative correlation of asphalt weatherability to this fundamental property of the asphalt.

Conclusions

A good correlation exists between the dispersibility of the least soluble asphaltenes derived from the coating grade asphalts and the Weather-Ometer durability of these products. Because of this relationship, measuring the dispersibility of the least soluble asphaltenes offers a quick method for estimating the durability of the asphalt. This estimate can be obtained within a few hours, whereas, by Weather-Ometer studies, the information requires several months.

The dispersibility of the least soluble asphaltenes is related to a fundamental property of asphalts, the solubility parameter of the asphaltenes. Thus, a significant value of this work is that asphalt durability is identified with this fundamental property.

[6] P. E. Graf, California Research Corp., unreported work (1959).
[7] Supplied by Phillips Petroleum Co.
[8] Supplied by Baker and Adamson Chemical Co.

Acknowledgment:

The author wishes to acknowledge S. H. Greenfeld, Research Associate, National Bureau of Standards, who conducted a substantial amount of this work during his employment at California Research Corp. Acknowledgment is given also to the American Bitumuls and Asphalt Co., whose sponsorship made this study possible.

APPENDIX

Modification of AASHO Test T 102-42

Procedure

Apparatus Required:

1. 400-ml beaker,
2. Two burets with Teflon stopcocks,
3. Whatman No. 2 filter paper, and
4. Glass stirring rod.

Solvents:

1. 99 mole per cent *n*-heptane,[7] and
2. Reagent grade xylene.[8]

Procedure:

Weigh into beaker 5.0 g of asphalt. Add 10 ml xylene to sample. Weigh sample plus xylene. Heat and stir gently until sample is dissolved. Reweigh sample and add sufficient xylene to restore its quantity to 10 ml.

Add *n*-heptane 1 ml at a time. After adding *n*-heptane, stir for 30 sec. Using the same stirring rod, place a drop of the sample on the filter paper. Permit the spot to spread out and dry. Keep repeating this procedure until a darker spot forms in the center of the spot. When this occurs, the spot is called positive.

After the positive spot appears, add xylene 1 ml at a time, stirring for 30 sec after each addition of xylene, until the spot disappears.

These steps are repeated until three positive spots have been obtained.

In this procedure, the point at which flocculation can be observed by the naked eye is arbitrarily taken as the end point. Actually, if the system is examined under a microscope, flocculation will be observed earlier in those steps in which *n*-heptane is added. Also, the spot will persist longer in those steps in which xylene is added to redisperse the flocculated bodies in the system. Thus, by the time a spot becomes visible to the naked eye, the point at which the first and least soluble asphaltenes have flocculated has been passed. Actually, a significant amount of the asphaltenes has been flocculated. However, if the end point is arbitrarily taken as that at which flocculation is noticeable to the naked eye, the data permit a comparative study. For the remainder of the discussion, a flocculated system will be considered flocculated only if it is visible to the naked eye. Similarly, a homogeneous system will be assumed to be a completely dispersed system if it appears to be uniform to the naked eye.

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(9) H. Burrell, "Solubility Parameters for Film Formers," *Official Digest*, Oct. 1955, pp. 726–743.

Punch-Card Handling of Atmospheric Test Data

By W. H. AILOR and M. R. HODGSON

A program has been devised which permits machine handling of all data derived from a 20-yr atmospheric test program. This program makes feasible the routine handling of thousands of test specimens and calculations by an accurate but rapid method. Inputs on the punched cards include exposure location, duration of test, mechanical properties, density, alloy type, and panel dimensions for both control and exposed specimens. The final machine-printed report gives the corrosion rate in mdd (milligrams per square decimeter per day) and mpy (mils per year), along with per cent changes in tensile strength, yield strength, and elongation due to corrosion. Flow charts giving visual descriptions of the somewhat complex procedures described in this paper are available from the authors on request.

A COMPREHENSIVE long-term atmospheric test program was initiated by the Metallurgical Research Laboratories in 1957. Basically the same plan as the 1957 program of Subcommittee VI of ASTM Committee B-3, the procedure called for triplicate exposures of 0.050- by 4- by 8-in. panels for periods of 1, 2, 7, and 20 yr at each of several tests sites. Twelve panels per alloy therefore were required per site.

In addition to the four ASTM sites, exposures were planned at eleven additional locations used by Reynolds Metals Co. for its test program. These included the Kure Beach, N. C., 800-ft site (site B); Corpus Christi, Tex., 60- and 150-ft sites (sites H and C); stations at McCook, Ill. (site E near Chicago); Richmond, Va. (site D); Phoenix, Ariz. (site F); Manila, Philippine Islands (site I); Widnes and Dungeness, England (sites L and K); and a Caribbean Sea location on the island of Aruba, Netherland Antilles (site M). Exposure panels for all test sites, plus duplicate control panels for initial tests and for each of the four exposure periods, required a total of 142 4- by 8-in. panels per alloy tested.

Initial data required for every panel totaled thirteen entries including: width, length, and thickness measurements; weight; panel identification; alloy type; exposure period; and test location. These entries did not include the triplicate values for tensile strength, yield strength, and elongation for each control panel nor the duplicate weighings and duplicate values after exposure for tensile strength, yield strength, and elongation—an additional ten or more items per panel.

Planning called for a total of 14,000 panels (approximately 100 alloys and alloy variations) by 1962, and since this involved the handling of at least 322,000 items of raw data, it became apparent that some rapid but accurate method of data handling was needed. The calculation of change in tensile, yield, and elongation values due to aging and corrosion, and the computing of corrosion rates in mils per year (mpy) and milligrams weight loss per square decimeter per day (mdd) further complicated the problem. The procedure outlined below answers these needs and allows considerable expansion in number of panels that can be included in the program without any substantial increase in time or burden in processing the data.

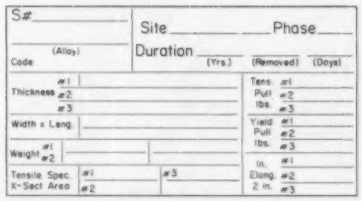

Fig. 1.—Form for entering test data on panel envelope.

Procedure

Since the panels were packaged individually with all data entered on a stamped form on the envelope (Fig. 1), such data could be punched into an IBM card (or series of cards) representing each test panel. Instead of mechanical test data for tensile, yield, and elongation values being calculated by the personnel testing the specimens, it was decided that such data as tensile specimen cross-sectional area, pounds pull tensile values, pounds pull yield values and elongation changes (in inches per two inches) should be entered directly on the envelope—the location of all original data.

WILLIAM H. AILOR has been a member of the Chemical Metallurgy Section of the Metallurgical Research Laboratories, Reynolds Metals Co., for five years. He received his education in chemistry and chemical engineering at the University of Tampa and North Carolina State College, and has been closely related to the long-range atmospheric test program since its inception. He is chairman of the task force of Subcommittee VI on Atmospheric Corrosion of ASTM Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys working on the 1957 20-year program. He is secretary of ASTM Committee B-3 and is a member of the Electrochemical Society and the National Association of Corrosion Engineers.

MALCOLM R. HODGSON is a senior systems analyst, Reynolds Metals Co., Richmond, Va. A graduate of West Virginia Business College, he has 20 years of background in systems, data processing, and computer programming. He has been associated with Reynolds Metals Co. since 1953, and is a member of Richmond Chapter of the National Association of Accountants.

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A notch system was used to make each panel unique when coded as to alloy, site, and panel number. A template was designed for this purpose (Fig. 2).

The Systems Department of Reynolds Metals Co., working with the Metallurgical Research Laboratories, devised the method of punch-card tabulation and verification and flow charts of the procedure for arriving at the final desired machine-printed reports.

The atmospheric test data are classified into four areas of testing for each alloy. These are

Area 1.—Standard properties (original properties of alloy).
Area 2.—Before exposure data (weight and dimensions of panels).
Area 3.—Control properties (changes due to aging alone).
Area 4.—After exposure properties (changes that include the effects of aging and corrosion).

Area 1.—Standard Properties

A table is prepared by the Metallurgical Research Laboratories (MRL) showing standard mechanical properties for the alloys to be tested. Data on the table include:

Series Code (identifies alloy).
Site Code (letter "A" indicates standard properties or control alloy, letter "B" indicates Kure Beach, N. C., 800-ft test site, etc.).
Panel number ("00" used for sequencing: panels 1, 2, 3—1-yr exposure; 4, 5, 6—2-yr exposure; 7, 8, 9—7-yr exposure; and 10, 11, 12—20-yr exposure).
Specimen number (individual panel identity, for example, 1B1 is alloy series 1; site Kure Beach, N. C., 800-ft site; 1-yr exposure).
Alloy name (for example, series 1 is alloy 1100 H14).
Standard mechanical properties as determined by ASTM Methods E 8:[1]
Tensile strength, kpsi; yield strength, kpsi, and per cent elongation in 2 in.
Density, g per cu cm.

The above data are keypunched into a series standard master IBM card (Fig. 3) in the Data Processing Center (DPC). These cards are later used to determine changes in mechanical properties of a test panel due to aging and corrosion.

Area 2.—Before-Exposure Properties

Before distributing panels to the exposure sites, the following measurements on each panel are made by MRL.

Thickness: three measurements (to 0.0001 in.),
Width: two measurements (to 0.01 in.),
Length: two measurements (to 0.01 in.), and
Weight: two measurements (to 0.0001 g).

Each measurement is recorded on the panel envelope (Fig. 1) along with phase number (designating the year in which alloy is initially placed on test), series code, site code, and panel number. These panel envelopes are then sent to DPC.

One IBM card is keypunched from each panel envelope (punching panel identity and all measurements). The cards are interpreted and a proof listing is made.

The multiple measurements are averaged, and the total area of each panel is calculated in two operations (IBM 604):

Operation 1.—Average of two weights.

Operation 2.—Average of three thicknesses; average of two widths; average of two lengths; total area of panel.

Before-exposure data cards are sorted in alloy, site, and panel number sequence and merged behind the series standard master card for each alloy. A before-exposure report is listed by alloy and site showing: alloy, standard mechanical properties, density, phase number, panel number, average measurements for dimensions, and total panel area (Fig. 4(*a*)).

Series standard master cards are separated from the before-exposure data cards. Before-exposure data cards are interpreted, printing average measurements and total panel area, and then

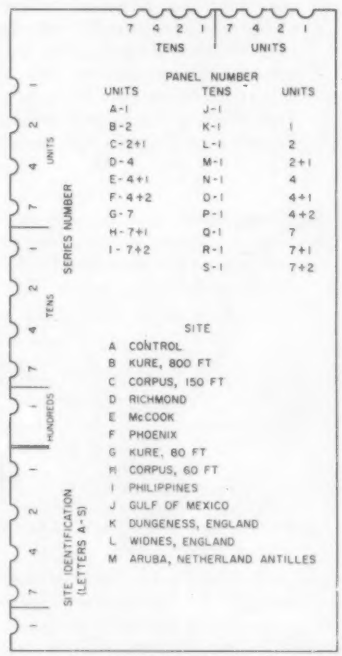

Fig. 2.—Test panel identification template.

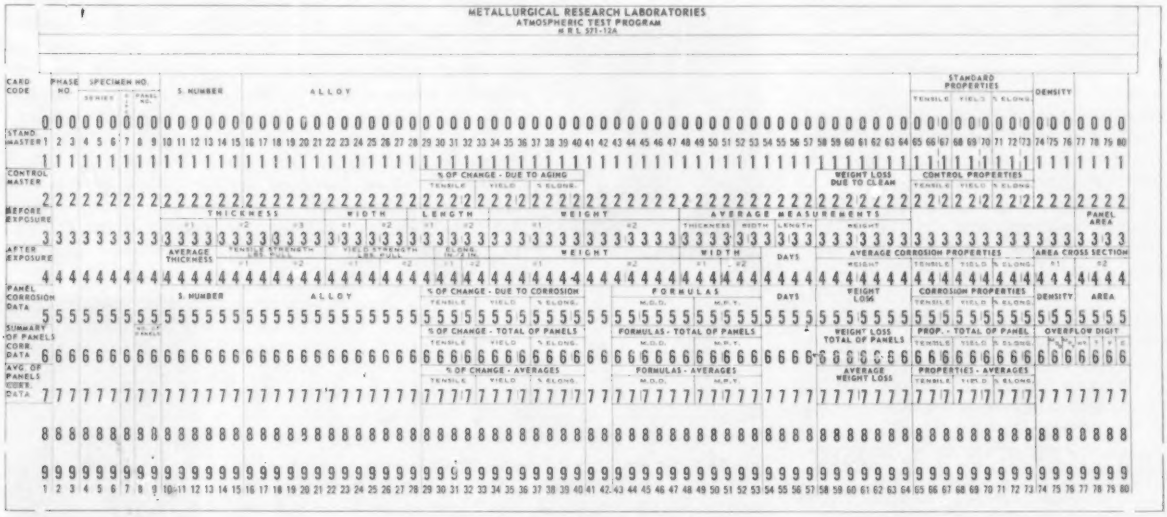

Fig. 3.—Corrosion data cards.

[1] ASTM Tentative Methods of Tension Testing of Metallic Materials, 1958 Book of ASTM Standards, Part 3, p. 103.

are sorted in panel-number sequence. Before-exposure report, series standard master cards, before-exposure data cards and panel envelopes are returned to MRL.

Panels to be exposed are distributed by MRL to the various exposure sites. Before-exposure data cards and series standard master cards are retained.

Area 3.—Control Panel Properties

Two panels per alloy for each removal period are weighed and measured using the same procedure as used for before-exposure panels and then placed in controlled storage conditions at the time each test phase of panels is exposed. These panels remain under control conditions for the same time period as each phase of exposed panels. At the end of each exposure period for a phase of panels, the control panels for that phase are removed from laboratory-controlled conditions. Their measured mechanical properties are compared with the standard mechanical properties to determine changes due to aging. These values are also compared with those from exposed panels to determine changes due to corrosion.

The control panels are cleaned, and two weight measurements are made for each panel. The two weight-change factors are recorded on the panel envelope.

Each control panel is then cut into three strips from which standard 8-in. tensile specimens are machined. The width of the reduced section of each specimen is measured and posted on the panel envelope.

Each of the three specimens for a panel is tested in tension. Factors derived from this test for each of the three strips from a panel are:

Tensile strength (pounds pull),
Yield strength (pounds pull),
Elongation in 2 in. (in.).

Each of these factors is posted on the panel envelope.

The average mechanical properties of the two control panels for each alloy are manually calculated by MRL using the formula that is used for the after-exposure calculations described below. A schedule of control mechanical properties is prepared showing: phase code, series code, alloy, weight change, tensile strength, yield strength, and per cent elongation in 2 in.

Standard master cards are selected from file for each alloy listed on the control mechanical properties schedule. Standard master cards and the control mechanical properties schedule are sent to DPC.

A control master card (Fig. 3) is keypunched for each alloy listed on the control mechanical properties schedule. Data punched include: card code, series number, site code "A," panel number "01," weight (gain or loss), tensile strength, yield strength, and per cent elongation in 2 in.

Standard master cards are matched with control master cards and cards are passed through the calculator to calculate per cent changes in mechanical properties due to control-panel aging. Factors calculated are per cent changes in tensile strength, yield strength, and elongation. Data gang-punched from the standard master cards into the control master cards are sample number, alloy, and density.

An aging report (Fig. 4(*b*)) is printed showing alloy, weight change in control panel (due to the cleaning technique), standard mechanical properties, control mechanical properties, and per cent changes in mechanical properties due to aging of control panels.

The aging report, control mechanical properties schedule, and standard master cards are returned to MRL for file. Control master cards are used in later mechanical processing of data.

Area 4.—After-Exposure Properties

The before-exposure data cards (coded with phase number and panel numbers which identify the panels due for removal from test) are removed from file by MRL prior to the end of an exposure period and sent to DPC where a panel recall listing is made showing site, phase code, series code, and panel numbers. DPC retains the before-exposure data cards and sends the panel recall listing to MRL, which distributes the panel recall listing to each test site for panels being recalled from each site. The panels are removed from test and sent to MRL.

MRL posts the number of exposure days on each panel envelope. The exposed panels are cleaned and two weight measurements are made for each panel. The two weight factors are recorded on the panel envelope.

Each panel is cut into two standard tensile strips as shown in Fig. 5. The width of each tensile strip is measured and each width factor is posted on the panel envelope.

Each of the two strips for a panel is subjected to the tension test. Factors derived from this test for each of the two strips for a panel are:

Tensile strength (pounds pull),
Yield strength (pounds pull),
Elongation in 2 in. (in.).

Each of these factors is posted on the panel envelope, and the envelopes are sent to DPC.

BEFORE EXPOSURE REPORT

Phase Code	Series Code	Panel No.	Sample Number	Alloy	Average Measurements: Weight (g)	Thickness (in.)	Width (in.)	Length (in.)	Area (sq. in.)	Standard Mechanical Properties: Tensile Strength 1000 psi	Yield Strength 1000 psi	Elongation %
	1 A		S 2488	1100 H14						18.0	16.7	6.3
1	1 B	1			68.9956	.0489	4.00	8.01	65.25			
1	1 B	2			68.8693	.0488	4.00	8.00	65.17			
1	1 B	3			69.3578	.0493	4.00	8.00	65.18			

FIGURE 4(a)

AGING REPORT

Phase Code	Series Code	Panel No.	Sample Number	Alloy	Weight Change Due to Cleaning (g)	Mechanical Property Change Due to Aging: Tensile Strength 1000 psi	Tensile Strength % Change	Yield Strength 1000 psi	Yield Strength % Change	Elongation %	Elongation % Change
	1 A					18.0		16.7		6.3	
	1 A	1	S 2488	1100 H14	- .0045	18.4	2.2	16.6	- .6	6.5	3.2

FIGURE 4(b)

AFTER EXPOSURE REPORT

Phase Code	Series Code	Panel No.	Sample Number	Alloy	Average Weight (g)	Days Exposed	Mechanical Properties Corroded Panels: Tensile Strength 1000 psi	Yield Strength 1000 psi	Elongation %
	1 A	1	S 2488	1100 H14	- .0045		18.4	16.6	6.5
1	1 B	1			68.9849	362	18.3	16.5	6.5
1	1 B	2			68.8490	362	18.3	16.5	6.5
1	1 B	3			69.3361	362	18.2	16.5	6.5

FIGURE 4(c)

PANEL CORROSION REPORT

Phase Code	Series Code	Panel No.	Sample Number	Alloy	Weight Change Due To Corrosion (g)	Corrosion Rate: mdd	mpy	Mechanical Property Change Due to Corrosion: Tensile Strength 1000 psi	Tensile Strength % Change	Yield Strength 1000 psi	Yield Strength % Change	Elongation %	Elongation % Change
	1 A	1	S 2488	1100 H14	- .0045			18.4		16.6		6.5	
1	1 B	1			.0062	.0041	.002	18.3	- .5	16.5	- .6	6.5	
1	1 B	2			.0158	.0104	.006	18.3	- .5	16.5	- .6	6.5	
1	1 B	3			.0172	.0113	.006	18.2	- 1.1	16.5	- .6	6.5	

FIGURE 4(d)

ALLOY CORROSION REPORT

Phase Code	Series Code	Panel No.	Sample Number	Alloy	Weight Loss (g)	Corrosion Rate: mdd	mpy	Mechanical Property Change Due to Corrosion: Tensile Strength 1000 psi	Tensile Strength % Change	Yield Strength 1000 psi	Yield Strength % Change	Elongation %	Elongation % Change
	1 A	1	S 2488	1100 H14	- .0045			18.4		16.6		6.5	
1	1 B	3			.0131	.0086	.005	18.3	- .7	16.5	- .6	6.5	
1	1 C	3			.0234	.0166	.009	18.3	- .5	16.7	- .4	5.9	- 8.7
1	1 D	3			.0767	.0496	.026	18.3	- .5	16.6	- .2	6.1	- 6.2
1	1 E	3			.4878	.3156	.167	17.9	- 2.9	16.3	- 1.8	6.3	- 3.6

FIGURE 4(e)

Fig. 4.—Atmospheric test reports.

An after-exposure data card is keypunched from each panel envelope (Fig. 3). Punched into each card are: phase number, series code, site code, panel number, all measured and test factors, and the number of days panels were exposed. A proof listing is made of the after-exposure data cards.

Average weight (after exposure) is calculated and punched into each panel card. The cards are sorted by series, site, and panel number.

The before-exposure data cards used to make the recall listing are merged (card for card) in front of the after-exposure data cards. The merged cards are processed through the calculator, and, in this operation, average mechanical properties (after exposure) and the cross-sectional areas of each of the two tensile strips from each panel are calculated. The following formulas describe this calculating operation:

1. Average panel thickness is read from the before-exposure card and punched into the after-exposure card.
2. Yield strength, kpsi = $(Y_1/W_1) + (Y_2/W_2)/Th \times 2$
3. Tensile strength, kpsi = $(T_1/W_1) + (T_2/W_2)/Th \times 2$
4. Elongation in 2 in., per cent = $(E_1/2) + (E_2/2)/2$
5. Area of tensile cross-section, strip No. 1 = $W_1 \times Th$
6. Area of tensile cross-section, strip No. 2 = $W_2 \times Th$

where (Fig. 5):

Y_1 = pounds pull, strip No. 1,
Y_2 = pounds pull, strip No. 2,
W_1 = width (in.), strip No. 1 (necked-down section),
W_2 = width (in.), strip No. 2 (necked-down section),
T_1 = pounds pull, strip No. 1,
T_2 = pounds pull, strip No. 2,
Th = average thickness of panel (in.) before exposure,
E_1 = elongation (in 2 in.), strip No. 1, and
E_2 = elongation (in 2 in.), strip No. 2.

These calculations are done with one pass of the cards through the calculator (IBM 604), using punch delay.

The control-properties master card for each alloy is merged in front of the before-exposure and after-exposure data cards. All cards are passed through the accumulating-reproducer machine (IBM 528). In this operation each control-properties master card is reproduced (duplicated), and one card for each test panel is punched (panel corrosion data card Fig. 3). Data punched into the panel corrosion data card include: sample number, alloy, and density (from control-properties master card); panel area (from before-exposure data card); and phase number, specimen number, days exposed, and mechanical properties of corroded panel (from after-exposure data card).

Weight in the after-exposure data card is subtracted from the weight in the before-exposure data card. Then the weight change in the control properties master card is subtracted from this factor to arrive at net change in weight for each corroded panel.

The duplicate control-properties master cards and the panel corrosion data cards are held for later processing.

Before-exposure data cards are separated from control-properties master cards and after-exposure data cards.

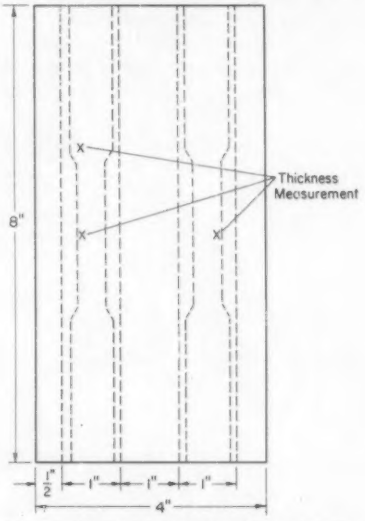

Fig. 5.—Plan for cutting tension test specimens.

An after-exposure report is printed (Fig. 4(*c*)) using control-properties master cards and after-exposure data cards. Information shown on the report includes: alloy, phase, site, and panel identity; control-panel weight change and control mechanical properties; weight change of corroded panels; the number of exposure days; and the mechanical properties of the corroded panels.

The after-exposure data report, control-properties master cards, before-exposure data cards, and after-exposure data cards are sent to MRL.

Duplicate control-properties master cards and panel corrosion data cards from a previous operation are separated.

Panel corrosion data cards are calculated to determine the corrosion rates as:

1. milligrams per square decimeter per day, mdd, and,
2. mils penetration per year, mpy.

Control-properties master cards are merged in front of the panel corrosion data cards. These cards are calculated to determine the per cent change due to corrosion for each of the mechanical properties (tensile strength, yield strength, and per cent elongation). This is accomplished by comparing properties obtained from the exposed panel in the panel corrosion data card with each control-property value in the control-properties master card.

A panel corrosion report is listed from the control-properties master cards and panel corrosion data cards (Fig. 4(*d*)). Data listed on the report are by alloy, site, and panel number. Data recorded show mechanical control properties for each alloy as well as weight loss, corrosion rates (mdd and mpy), mechanical properties, and per cent change in mechanical properties due to corrosion for each corroded panel. During the printing operation an alloy summary card (Fig. 3) is punched for each alloy and test site. The three panel cards for each alloy and test site are totaled. The data punched into the summary card include: phase code, series code, site code, alloy and totals for three panels for factors of weight loss, corrosion rates (mdd and mpy), mechanical properties, and per cent change in mechanical properties due to corrosion. The number of panels from which these data are derived is summary-punched into the panel number field.

A blank card is merged behind each alloy-summary card. The cards are processed through the calculator (IBM 604) three times, punching the following data into the blank cards:

1. Phase code, series code, site code, number of panels, sample number, alloy and averages for the weight loss and corrosion rates (mdd and mpy).
2. Averages for tensile strength, yield strength, and per cent elongation.
3. Average per cent change in mechanical properties (due to corrosion) for tensile strength, yield strength, and per cent elongation.

The alloy-summary cards and alloy-average cards (Fig. 3) are separated. The duplicate control-properties master cards from a previous operation are merged in front of the alloy-average cards. An alloy-corrosion report (Fig. 4(*e*)) is printed showing the alloy, phase code, series code, site code, number of panels averaged, net weight change, corrosion rates (mdd and mpy), mechanical properties, and per cent change in mechanical properties due to corrosion.

The panel-corrosion report, alloy-corrosion report, panel-corrosion data cards, alloy-summary cards, and alloy-average cards are sent to MRL. The duplicate control-properties master cards are destroyed.

A complete flow chart showing all machine operations is available from the authors on request.

Conclusion

The outlined program, whereby raw atmospheric test data are punched into cards, gives both speed and accuracy

in deriving corrosion rates and mechanical-property changes. The system is adaptable to immersion and other exposures and can be used for laboratory and plant studies as well as field tests. Hundreds of thousands of test specimens can be handled in a systematic procedure.

The usual corrosion-rate factors (mdd and mpy) plus changes in tensile strength, yield strength, and per cent elongation, are included on the final machine-printed report. Proof listings of all specimens and test data permit easy "back checking" to determine at what point unreasonable or erroneous information was entered.

The machine computation of all mechanical properties—tensile and yield strengths, and per cent elongation—from the actual pounds pull and inches elongation values (taken directly from the tensile machine curves) has eliminated the tedious and time-consuming hand calculation previously used.

The program has been planned for future expansion to include additional test sites, new alloys, expansion of the number of specimens within a test period, and new data such as pit depth and color change factors.

Acknowledgments:

The basic concept and early development of this program are due, to a large extent, to the leadership of H. Lee Craig, Jr., of the Metallurgical Research Laboratories staff. The support, encouragement, and advice of the following persons has made this work possible: S. John Sansonetti, assistant director at Metallurgical Research Laboratories; Gordon H. Robertson, manager of the Systems Dept.; and Hubert W. Roach, manager of the Tabulating Dept. The help of Charles E. Somervell, systems analyst, in the development of the program also is acknowledged. At Metallurgical Research Laboratories, J. R. Scott and H. B. Romans have devotedly and consistently maintained the high standards of accuracy required in this program.

In addition to the above Reynolds Metals Co. personnel, W. Thomas Eley and James E. Hall of the IBM organization helped in developing this technique. The template for notch-coding test panels was developed from the plan devised by Fred Reinhart of the National Bureau of Standards.

Use of a Modified MacMichael Viscometer for Consistency of Printing Inks and Ink Vehicles*

By R. CUMMINGS

THE MACMICHAEL VISCOMETER was chosen many years ago in the control laboratory of The California Ink Co., Inc., as the most suitable instrument available for routine measurements of consistency of printing inks and ink vehicles. Some of the features that recommended it for this use were:

1. Readings may be taken very rapidly, especially as compared to instruments in which time is the quantity measured,
2. A very wide range of consistencies can be measured with one instrument,
3. A relatively small sample is required,
4. The parts of the instrument in contact with the sample are easily cleaned, and
5. The results are in absolute, (not kinematic) viscosity, an advantage when samples differ widely in specific gravity.

A set of uniform test conditions was chosen to be used for all samples, namely:

Temperature	25 C
Rotational speed	20 rpm
Inner cup diam	3 cm
Cylindrical plunger diam	1 cm
Plunger immersed in sample	3.53 cm

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* Presented at the Third Pacific Area National Meeting, San Francisco, Calif., Oct. 11–16, 1959.

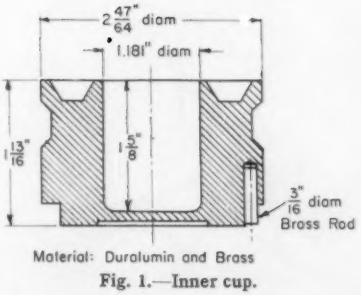

Fig. 1.—Inner cup.

It is possible to test materials under these conditions with the standard MacMichael viscometer, but certain alterations have improved its convenience for routine work. These modifications are described below.

Description of Viscometer

A synchronous motor with two worm-gear speed reducers rotates the cup at 20 rpm. A new inner cup is shown in Fig. 1. This cup is of massive construction to afford large heat capacity which protects the sample from temperature changes. The heavy section of metal insures rapid equalization of temperature throughout the cup. It is intended that the sample fill the cup, thus establishing the specified depth of immersion of the cylindrical plunger. The annular groove in the top surface of the cup holds the overflow of sample that occurs when the cylindrical plunger is inserted and also retains a supply of material in thermal contact with the cup, which can be used to refill the cup if the test has to be repeated. The new cup is designed to drop into place in the outer cup with little need for careful positioning by the operator.

Figure 2 shows mechanical details of the viscometer.

A locking device to hold the torsion wire is shown in Fig. 3. This device prevents the torsion wire from being

ROSS CUMMINGS, group leader, Analytical Laboratory, Research and Development Laboratories, The California Ink Co., Inc., Berkeley, Calif. He has had 38 years experience in the fields of measurement, analytical chemistry, chemical engineering, sodium phosphates. During the war, he was a chemist on the Manhattan project at the University of California Radiation Laboratories. Prior to joining California Ink he was with the Emeryville Chemical Co. (silicates and alkalies).

detached from its support, even when very viscous samples are tested.

The spindle dials are graduated in poises instead of MacMichael degrees. To cover the range of samples, wires in 16, 18, 20, 22, 26, and 30 gage sizes are used, each mounted in its own spindle. The dial graduations were computed by substituting the appropriate dimensions in the equation for the torsion viscometer. The instrument was calibrated by the use of Viscosity Standard Samples P-4 and N-11 of the National

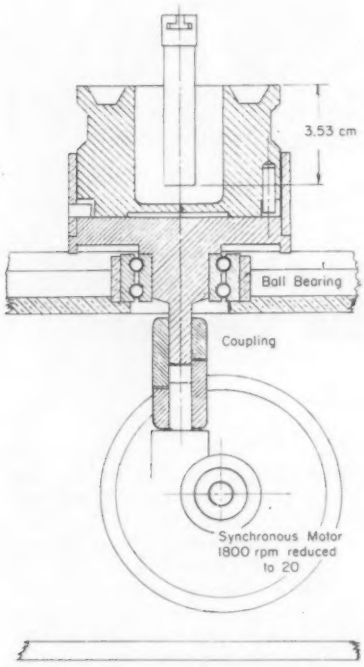

Fig. 2.—Section showing motor, bearing, outer cup, inner cup, and cylindrical plunger.

Bureau of Standards. These samples, at 30 C, have viscosities of 609.4 and 6.181 poises, respectively. By working at temperatures from 4.5 to 63.5 C, the range of measured viscosities is extended from 1 to 11,000 poises. It was found that the measured torque has to be reduced by a factor of 0.976 to yield correct results in poises. The excess torque is probably due to forces operating on the end of the plunger. The dial graduations were corrected by this factor. Data used for graduating the dials are given in Table I.

TABLE I.—DATA FOR CONSTRUCTING GRADUATED DIALS FOR MACMICHAEL VISCOMETER.

Using 1-cm. cylindrical plunger, 3-cm cup, 3.53-cm immersion, 20 rpm, and calibration factor 0.976.

Wire Gage	Torsion Constant, g-cm per deg	Poises per Division	End-of-scale Poises	Poises per Division
30	0.01131	1	150	2.413
26	0.07132	5	550	1.913
22	0.4285	20	2 300	1.274
20	1.129	100	3 500	2.418
18	2.703	200	9 000	2.020
16	6.479	500	14 000	2.106

To extend the range of the instrument for low-viscosity materials, a cylindrical plunger having an outside diameter of 2.235 cm (0.880 in.) is used. This plunger produces exactly ten times the torque of the 1-cm plunger. When it is used, the dial reading is divided by 10 to get poises.

Apparatus used in routine work, in addition to the MacMichael instrument itself, includes Engler viscosity ther-

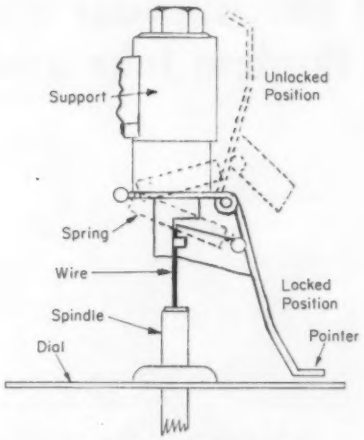

Fig. 3.—Wire-locking device.

mometers (ASTM Thermometer 23C),[1] a Tele-Thermometer[2] with stainless steel tubular probe and graduated in 0.1-C divisions from 20 to 30 C, a water bath thermostatically controlled at 25 C, and a spatula with a 4-in., square-end blade.

The MacMichael instrument is kept on a firm table and leveled so that the spindles hang in the center of the guide yoke. No oil is used in the dashpots. The room temperature is kept near 25 C.

Procedure

The cup is filled with the sample, using care to avoid entrapping air bubbles, and then placed in the water bath. Water should not be permitted to enter the cup. The thermometer is thrust into the sample and allowed to remain until it reads 25 ±0.2 C. A spindle is selected with wire suitable for the sample. When ready, the cup is transferred to the viscometer, the thermometer is removed, the plunger is thrust into the sample, and the spindle is hung from the support with its wire locked in place. The dashpot is adjusted in the guide fork and the motor is started.

Using the spatula, the excess sample is scraped away from the plunger as the cup rotates and the sample surface is made level with the top surface of the cup. The consistency in poises is read from the dial. The temperature of the sample is read with the Tele-Thermometer and if unchanged, the consistency reading is recorded. If the temperature is out of range, the consistency reading is discarded, and the cup with sample is returned to the water bath for further conditioning.

In the case of pigmented materials which have high yield value or display thixotropy the sample is stirred vigorously with the plunger attached to the spindle before the spindle is hung in the instrument. Several readings are taken, alternated with stirring, until the operator is sure that a minimum consistency reading has been obtained.

The precision of the determination varies with the type of material and the magnitude of the consistency. Values for a clear vehicle at 100 poises may vary less than two poises above or below the average. Values for a pigment dispersion at 3000 poises may vary 50 poises above or below the average.

A proficient operator can test an average lot of samples at the rate of 15 per hr. In case of need for an immediate answer, it is possible to test a sample in 2 min if its temperature is near 25 C when received by the operator.

The availability of this method of testing, which provides data at a reasonable cost or in a very short time, has enabled the California Ink Co., to control its products in narrow consistency ranges and provide its customers with a uniform product.

Acknowledgment:

The author acknowledges the valuable assistance in the development of this apparatus and procedure given by numerous supervisors and technicians over a period of years in the control laboratory of the California Ink Co.

[1] Standard Specifications for ASTM Thermometers (E 1), 1960 Supplement to Book of ASTM Standards, Parts 6 and 7.

[2] Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio.

A New Impact Detonability Tester for Evaluating Materials with Highly Reactive Oxidizers*

By RAYMOND C. KOPITUK

Over the past several years, increased interest in the detonation characteristics of materials with highly reactive propellants has resulted in the need for a reliable, inexpensive method for determining these characteristics. This paper discusses the investigation which Reaction Motors Division, Thiokol Chemical Corp. conducted to develop a simple drop weight type of tester. The discussion covers the problems associated with some early testers and the important features which were incorporated into the present RMD tester.

Photographs of the prototype and final tester are presented.

The critical parts of the tester are discussed in detail and some of the data that has been accumulated with this equipment on liquid propellents is presented graphically. Information is also presented which indicates the reliability and sensitivity of the equipment.

An oil contamination system is described which should be very helpful in exploring the general impact problem as it concerns the industry in that it will (1) permit data conversion between different style testers over the complete sensitivity range, and (2) serve as a standard for tester calibration.

With the advent of the rocket engine and missile into industrial prominence, the need for development of higher performance propellants has been a necessity. The latter development has resulted in a wide variety of propellants which, in many cases, are highly reactive. These propellants are reactive not only with other propellants but also with metal, ceramic, plastic, and liquid materials with which they may come into contact during construction or operation of the rocket engine or missile. For example, the propellants used in the XLR-99 (Fig. 1) made by the Reaction Motors Division for use on the X-15 manned spacecraft are 90 per cent hydrogen peroxide, liquid anhydrous ammonia, and liquid oxygen. Two of these, the hydrogen peroxide and oxygen, are potentially detonable when in contact with certain materials.

Several years ago when the rocket engine industry began using highly reactive oxidizers such as liquid oxygen and concentrated hydrogen peroxide, the basic methods of evaluating the compatibility of materials was to immerse the material or component in the propellant, determine reactivity through decomposition of the propellant, or examine the effect of the propellant on the material surface and drop a weight of some magnitude on the material when in contact with the propellant. Most of the concern with detonability was centered around liquids, greases, or paint systems. However, as more experience was gained, it became evident that many of the plastic, elastomeric, and metal materials were also susceptible to detonation when in contact with liquid oxygen, hydrogen peroxide, or the newer inhibited red fuming nitric acid. At the same time, it became evident that just dropping arbitrary weights on pieces of material in propellant was not

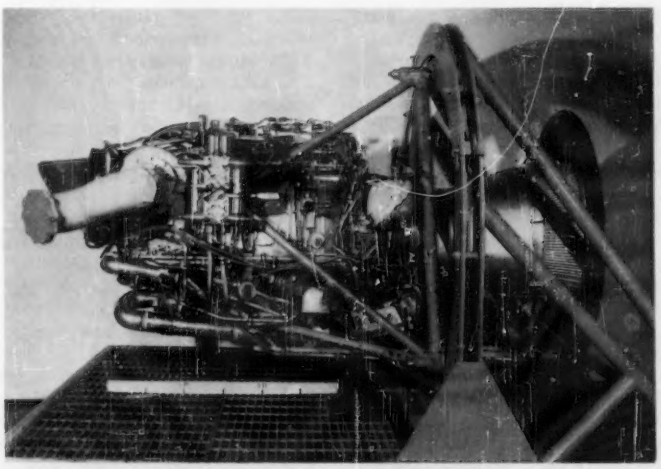

Fig. 1.—XLR-99 rocket engine using hydrogen peroxide, liquid anhydrous ammonia, and liquid oxygen propellant.

RAYMOND C. KOPITUK dates his rocket and missile experience from the time he joined Reaction Motors Division, Thiokol Chemical Corp. in 1950. One of his primary fields of interest has been the compatibility of materials with rocket fuels and oxidizers. Now, as manager of Metallurgy and Materials, he is still vitally interested in compatibility of materials for rocket service and in particular, the impact sensitivity of materials to detonation when in contact with highly reactive oxidizers.

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* Presented at the Sixty-third Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 27–July 1, 1960.

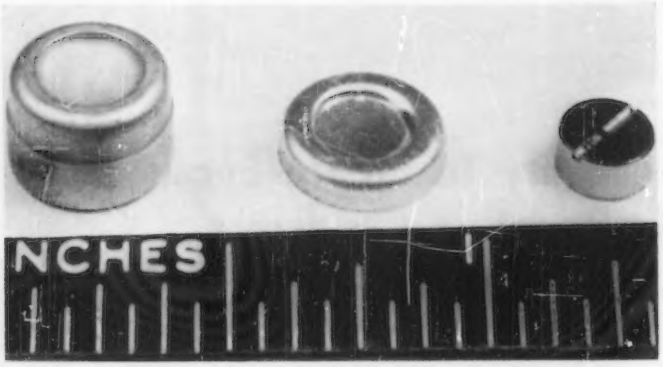


Fig. 2.—Components of the sample cup assembly.

Fig. 3.—Complete assembly of sample cup.

good enough to determine the detonability characteristics.

Early in 1953, the Reaction Motors Division began a study of detonability characteristics on solids such as silicone rubber, TFE fluorocarbon plastic, natural rubber, and some metals and ceramics. At the same time, a program was initiated to evaluate the various types of impact testers available to the industry and select one that was safe, reliable, and relatively inexpensive to build and operate. Most of the test equipment in use, which included our own impact tester, was bulky, awkward, and usually required a separate room where testing personnel would not be exposed to the abnormally large blasts resulting from impact-sensitive materials. Another objection to the equipment was the poor reproducibility of data from the drop-weight testers. We investigated the use of striker pins having a relatively large area and found that the pin did not strike normal to the surface. Generally, the larger the area to be covered during impact, the greater the possibility of misalignment, which yielded very erratic test data. Also, with large striker areas, it was necessary to use large plummet weights (20 to 70 lb).

The Card Gap Test for shock sensitivity measures the minimum hydrodynamic shock necessary to produce propagation of a high order detonation in a specified diameter steel pipe. A test of this type had been used for about 15 years in the testing of the sensitivity of solid and liquid propellants toward shock waves. However, for our purposes, the tests appeared to be unsatisfactory for two reasons: (1) large quantities of detonable materials had to be mixed for each test and consequently, personnel within the immediate area of the tester would be in a hazardous area, and (2) the test was very time consuming. Furthermore, for solid materials, this type of test did not apply a sufficient number of parameters associated with a mechanical impact in actual service.

It was finally decided that a drop-weight type of tester be developed. It was further considered mandatory that the test require only a few drops of propellant and sample so that optimum safety conditions would be realized. Further, it was recognized that with small contact areas between striker pin and the anvil, the effect of eccentric loading on the sample during impact could be minimized.

A drop-weight tester was designed with several important features in mind:

1. The rail system was aligned accurately to guide the drop weight on a perpendicular course to the anvil;
2. The bed plate and supporting structure were constructed of materials with low damping capacity;
3. Arrangements were made for accurate temperature control;
4. A shatterproof, transparent casing enclosed the equipment for the protection of personnel observing the test as well as to exclude dust, and in addition to the above, a most important item was the design of the sample cup assembly which holds the propellant and the test sample. A simple tiny cup (Fig. 2) was used to handle liquid propellants. Propellant and sample are placed into the shallow cup. The cup is covered with a thin sheet metal cap and a striker pin is centered in a recess on the cap (Fig. 2). The complete assembly is shown in Fig. 3. For liquids with higher boiling points such as hydrogen peroxide, the sample area is covered by the cap. As the plummet hits, a high pressure is instantaneously created along with mechanical working of the sample as the striker pin is projected into the sample below.

When testing materials with liquid oxygen, a cap having small holes is used to admit liquid oxygen as well as to vent gas bubbles. Liquid oxygen is poured into a reservoir surrounding the anvil until the level is somewhat above the striker pin. The plummet is dropped when the cup assembly is cooled to the temperature of liquid oxygen.

The sample cup is designed with a slight curvature for two reasons: (1) it compensates for small misalignments of the striker pin, and (2) it traps liquid beneath a solid type of material so that both hydrodynamic pressure and mechanical work are created at the same time.

Positive reactions are recorded by audible detonation, flashes, and the presence of burning in the cup. The shock sensitivity threshold value of any material is determined by starting the testing at a maximum of 36 in. and lowering the starting position of the weight a few inches with each successive drop (if a positive reaction occurs) until the highest value is obtained where ten successive drops may be made without causing a detonation or reaction. Thus, inert materials have very high threshold values, while active materials have very low threshold values. Data are recorded in foot-pounds per square inch of contact area calculated from the striking surface of the striker pin. In determining detonability the sensitivity in drop height of this impact tester is ± 1 in. or ± 11 ft-lb per sq in. As mentioned before, low damping capacity materials have been used for the tester bed plate and the same applies to the cup and striker pin. High-damping materials would tend to absorb the shock of impact by the plummet and striker pin and, consequently, lessen the sensitivity of the materials to detonate. Low-alloy high-strength steel in the hardened condition has been used as base material. Recently tests run in our laboratory indicate that the 300 series stainless steels will be satisfactory

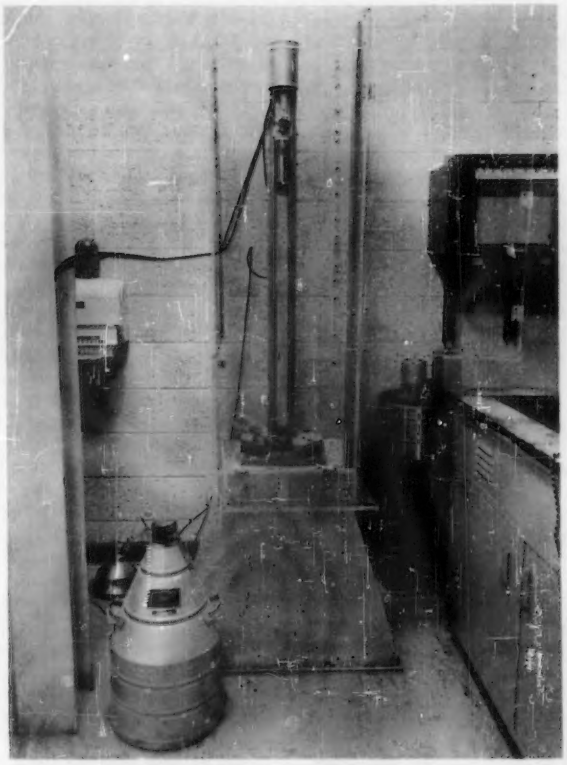


Fig. 4.—Early version of testing unit.

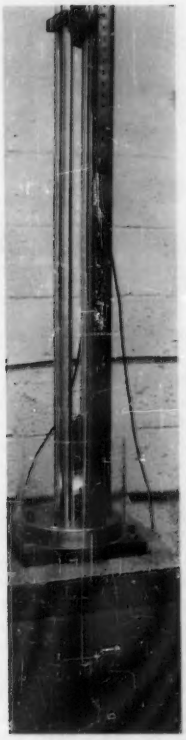
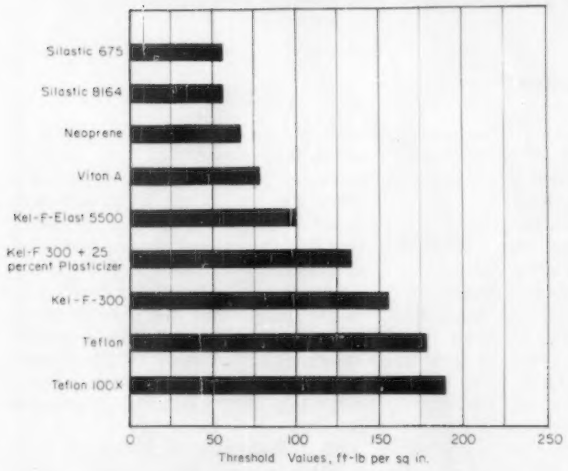
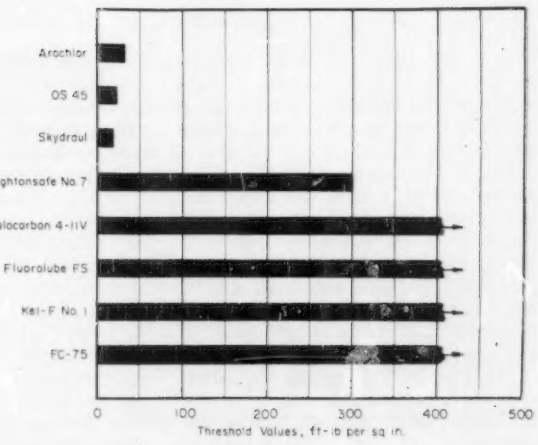


Fig. 5.—Final design of testing unit.



(*a*) Plastics.



(*b*) Hydraulic fluids.

Fig. 6.—Shock sensitivity threshold values in liquid oxygen.

for the cups. For compatibility purposes, the low-alloy steels have been plated with chromium.

A photograph of one of our earlier units is presented in Fig. 4. Actual testing is performed on one of our units shown in Fig. 5 in its final design. For convenience, a 2-kg plummet is used except for occasional checks on the equipment. Other weights as low as 500 g have been used with no change in the resultant test values.

The results of testing some plastics and liquids with liquid oxygen is shown in Figs. 6(*a*) and (*b*) and the results of testing some plastics with 90 per cent hydrogen peroxide are shown in Fig. 7. In general, we have found that the sensitivity of detonable materials increases twofold or more when testing in liquid oxygen than in 90 per cent hydrogen peroxide.

In some very recent work performed in our laboratory, we attempted to determine the sensitivity of the equipment by increasing the contaminant in what previously had been determined to be a completely compatible material. In this program, several blends of Halocarbon 4-11V and a polyalkylene glycol oil were tested for impact sensitivity with liquid oxygen. The blends ranged from 5 per cent to 100 per cent halocarbon oil.

The results of this impact sensitivity study are presented in Fig. 8. Having

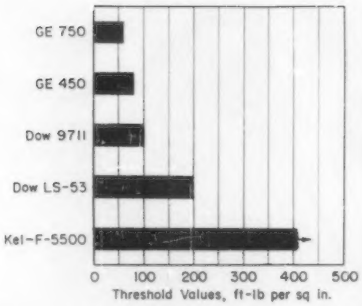


Fig. 7.—Results of tests on plastics with 90 per cent hydrogen peroxide.

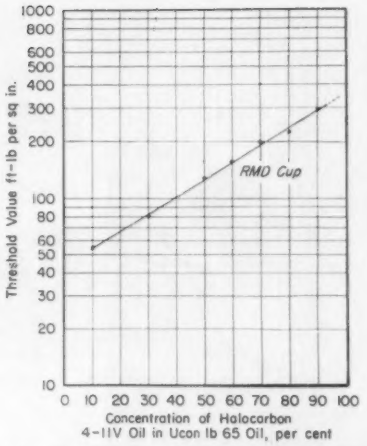


Fig. 8.—Results of impact sensitivity study.

once established the threshold value, a series of ten tests was performed for each point on the curve. Note that as the halocarbon oil is added, the mixture becomes less sensitive to impact (the threshold value rises) and that a straight line energy relationship results when plotted on a semilogarithmic scale. The straight line holds only within the range shown. As the halocarbon percentage is lowered or increased at each end, the threshold value, respectively, drops or increases sharply. These data have been reproduced many times over the past three years even when these solutions were stored for several months prior to testing. Other materials, some of which have been discussed in this paper have also been retested with repetitive results.

Conclusion

In the past few years, a considerable quantity of data on this equipment have been accumulated. These data have been used by our design personnel as design data. Experience with our rocket engines has proved that the data can be used as one would use the tensile properties of materials for design purposes, and so, though a material might have a threshold value for detonation of 300 ft-lb per sq in. in liquid oxygen, it does not necessarily mean that the material cannot be used in liquid oxygen.

In general, our experience with the tester has indicated its reliability and reproducibility and has allowed us to use a greater variety of materials with reactive propellants than might otherwise be used.

With the halocarbon oil system described previously, it is possible to obtain any threshold value within the range shown. This system should be very helpful in exploring the general impact problem. It will permit data conversion between different styles of testers over the complete sensitivity range, and it will serve as a standard for tester calibration.

At the present time, many types of testers are being used and a mass of widely varying data is being accumulated. Some effort by the government and industry is being made through the AIA and WADC to establish standards for procedure and specify testing equipment required.

It is our recommendation that a tester and an alternate, if favorable comparable data for the alternate exists, be established as quickly as possible as standards for the industry so that data between various agencies can be properly correlated for this very important phase of materials compatibility testing.

DISCUSSION

MR. C. B. PUTNEY.[1]—How large a specimen is needed when testing a solid such as Teflon?

MR. R. KOPITUK (*author*)—Generally, we use a 0.010 in. thick specimen. We have a small die which cuts out a disk about $\frac{1}{8}$ in. in diameter. Figure 2 shows the size. This has on it an inch-scale, and you can get an idea of the size we are talking about. The cup holds the specimen, and, of course, it has to be within that size.

MR. PUTNEY.—When you are testing a powdery material, do you try to fill the small cup level, or what procedure is used?

MR. KOPITUK.—When we test a powdery type of material, it is difficult to correlate this into foot-pounds per square inch, obviously there is a lot more area involved in the specimen. In that particular case, we generally record that the material is powdered. We will use foot-pounds per square inch as associated with the surface of the striker pin, but it is hard to correlate powder into foot-pounds per square inch, as you probably realize.

MR. FRANK M. WILLIS.[2]—Have any correlations been made with changing the weight level at a given distance so you would get constant velocity, or did you make variations only in height?

MR. KOPITUK.—Our variation was in height only. We generally used a 2 kg weight. We have used other weights as low as 500 g, and the resultant test values have remained the same. Our loss in free falls stays pretty much the same, and the loss we have calculated to be about 2 to 3 per cent. There have been some studies which resulted in statements that constant velocity are necessary. The data we have examined on this subject, to date, have been very vague. We suspect that the equipment being used has a wide variation in free fall at different heights.

MR. WILLIS.—I was wondering, too, about the compression of any oxygen outage that might be around the sample, compression due to the impact. Does this have much bearing on the test?

MR. KOPITUK.—It is our feeling, and we have done quite a bit of testing along these lines, that you have to have gas present with the liquid oxygen. You do not get a detonation in liquid oxygen as such. It is our feeling that it is the gaseous oxygen that helps initiate the detonation.

MR. WILLIS.—There is a device, one of the many that you mentioned as being available, that utilizes a definite known outage of gas with the sample; these are liquid specimens generally. With this unit, adiabatic compression is a very significant factor.

MR. KOPITUK.—We thought very seriously about getting into really accurate control on the amount of gas coming out of the area. However, with the tests that we have run so far, in this equipment, we do not, for all practical purposes, have to be too concerned about it. Our test simulates to a large degree what you might get in actual service. In most rocket engines using liquid oxygen there is bound to be some gas formation, so we feel that what we are getting here simulates what we might get in service.

MR. WILLIS.—Is there much difficulty or difference in calibration of the unit whether it is mounted on a very firm

[1] Consultant, Engineering Service Division, Materials Handling, Packing, and Distribution Group, Engineering Dept., E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

[2] Mechanical Engineer, Explosives Research, E. I. du Pont de Nemours and Co., Inc., Eastern Laboratory, Gibbstown, N. J.

foundation or just on the floor.

MR. KOPITUK.—With the original unit, yes. We could not get proper detonation with the old prototype on the floor. However, with the present unit we can test on the floor. Looser fits in the old design may have had something to do with the erratic results on the floor. Actually both instruments are handled more conveniently on a mount. The mass at the base is critical.

Alignment is also critical. The plummet that we have is guided by the three bars in the final design shown in the photograph, and we have nonmetallic O-rings which are the actual guide elements of the plummet. I think the tolerance between the bars and the O-rings is somewhere around 0.015 or 0.030 in.

MR. WILLIS.—At Eastern Laboratory we have a unit similar to this used in explosives research. We have had it in service some 20 years, and we found that moving it off its concrete foundation or modifying it in any way can change results. Several of the new units available on the market have apparently overcome this problem, and we were interested in knowing how serious a problem it was.

MR. KOPITUK.—I know one fabricator on the West Coast who has this new piece of equipment, and he did not have time to get the pedestal and everything else working, so he just placed it on the floor, and he did get fairly good results that correlated with our Halocarbon system.

MR. W. H. GRUMET.[2]—I noticed that in these tests the temperature was kept fairly constant—you made provisions for that. Have you done any work on checking shock sensitivity measurements in other environments? I am particularly thinking, say, of an acoustic environment. This does not primarily relate to your tester, but to the end use of it.

Are there any correlating data? Would you get the same results, say, under a high acoustic environment, or other climatic or dynamic environments, and could you correlate these results with present available data and techniques? Under actual rocket conditions you encounter high acoustic energy levels, and my feeling is that you would obtain different results using your present equipment but adding another environment.

MR. KOPITUK.—No, we have not done anything like this. There is no doubt that there might be some effect, because you are talking about loading, and if you had the vibrator with a high-frequency cycle attached to tester base, you might pick up the load just at the right cycle and set it off at a lower value. This piece of equipment cannot be used to define exactly what you are going to get in a rocket engine. It is merely a means of evaluating materials against one another. However, if you knew the frequency of a particular component in an engine, it could be superimposed on our tester to more clearly define the effect of that particular frequency on the detonation characteristics for that particular part.

[2] General Manager, American Laboratories, Fullerton, Calif.

This one of a series of photographs from a collection compiled by Prof. Jasper O. Draffin and displayed in the Arthur N. Talbot Laboratory, University of Illinois.

William Whewell (1794–1866). Born in England, Willam Whewell was a mathematician, philosopher, and writer on the history of science. His "History of the Inductive Sciences" is a critical analysis of the development and growth of the mathematical sciences.

"Men in the outset of their attempts at knowledge are prone to rush from a few hasty observations of facts to some wide and comprehensive principles . . . and then to frame a system on these principles. This is the opposite of the method by which the Sciences have really and historically been conducted, namely, the method of gradual and cautious ascent from observation to principles of limited generality, and from them to others more general. This latter, the true Scientific Method, is Induction, and has led to the Inductive Sciences."

History of the Inductive Sciences, Vol. I.

Actions on Standards

(*Continued from p. 19*)

strength test, an electrode configuration sensitive to the detection of contaminants which adversely affect the dielectric strength, and capable of accurately evaluating the upper limits of dielectric breakdown of an oil, is important as a tool in the design of oil-filled equipment. This test provides increased sensitivity over the Standard Method of Test for Dielectric Strength of Insulating Oil of Petroleum Origin (D 877).

Non-Ferrous Metals and Alloys

Tentative Specification for Zirconium and Zirconium Alloy Forgings and Extrusions for Nuclear Applications (B 356 – 60 T)

New Tentative.—The specification was developed in response to the demand for coverage of zirconium and zirconium alloy forged and extruded parts by the nuclear industry. Two grades of zirconium are covered—R-1 (unalloyed reactor grade), and RA-1 (alloyed reactor grade). It is a companion to four existing specifications for zirconium and zirconium alloys for nuclear application, namely, B 350 (ingots), B 351 (bars, rod and wire), B 352 (sheet, strip, and plate), and B 353 (seamless and welded tubes).

Methods of Testing

Tentative Specification for Standard Atmospheres for Conditioning and Testing Materials (E 171–60 T)

New Tentative.—This specification defines the atmospheres for normal conditioning and testing of materials, in approximately ambient conditions, which have been accepted by ASTM. Portions of this specification have appeared in E 41–57 T (Definitions with Procedures Relating to Conditioning and Weathering), which is now being separated into two parts, one covering specifications of standard atmospheres and the other an extensive list of definitions. The definitions are still under study and will be submitted later.

Tentative Methods of Verification of Testing Machines (E 4–57 T)

Revised.—Section 17 which has required testing machines in constant use to be verified every six months, has been changed to require verification at intervals of at least 12 months.

Tentative Method of Test for Brinell Hardness of Metallic Materials (E 10–58 T)

Revised.—The revision clarifies the significance of the magnitude of the test load with respect to the hardness range of the material and the load accuracy recommended for Brinell hardness machines used for routine acceptance testing.

Tentative Methods of Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials (E 18–59 T)

Revised.—The revision provides an alternate method with respect to the use of calibration blocks.

Tentative Method of Rapid Indentation Hardness Testing of Metallic Materials (E 103–54 T)

Revised.—Changes have been made in order to keep the method in agreement with the revised Tentative Method of Test for Brinell Hardness of Metallic Materials (E 10) referred to above.

Tentative Definitions of Terms Relating to Methods of Mechanical Testing (E 6–58a T)

Revised.—The definitions for elongation and reduction of area were revised in an attempt to have a single definition for these terms for both the metals and plastics industries, and 32 definitions relating to fatigue were added.

Standard Hardness Conversion Tables for Metals (Relationship Between Brinell Hardness, Diamond Pyramid Hardness, Rockwell Hardness, and Rockwell Superficial Hardness) (E 140–58)

Tentative Revision.—In Table IV on Hardness Conversion for Nickel and High Nickel Alloys, equivalent Knoop hardness numbers have been provided.

Manufactured Masonry Units

Tentative Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units (C 126–59 T)

Revised.—In Section 16(*b*) covering the imperviousness test, the words "standard blue-black fountain pen ink" have been changed to "permanent blue-black fountain pen ink." A note has been added to the section to read, "Shaeffer's Skrip Permanent Blue-Black writing ink, No. 232, has been found satisfactory for this test."

Standard Specification for Building Brick (C 62–58)

Tentative Revision.—In Section 3(*a*) on size, the first sentence is being changed to read, "The size of brick shall be as specified by the purchaser." This change deletes the phrase, "and the average size of brick furnished shall approximate the size specified in the invitation for bids."

In the second sentence of Section 4(*a*) on visual inspection, "small chipping" is being changed to "chipping."

Thermal Insulating Materials

Tentative Method of Test for Mastic Coatings Used in Connection with Insulations (C 461–60 T)

New Tentative.—These methods are intended for the examination of mastic coatings for use as weather and vapor barriers over thermal insulations and for other accessory use. They are based on the composition of such coatings being principally binders as bitumens with water, chemical solutions, or solvents as dispersants, and with or without addition of mineral fillers and various addition agents.

Tentative Specification for Mineral Fiber Blanket and Felt Insulation (Industrial Type) for Low Temperatures (C 264–55 T)

Revision.—The changes are based upon further knowledge of the product, its use, and improvements.

Standard Specification for Mineral Fiber Thermal Insulating Cement (C 195–48) Revised and Reverted to Tentative.—Changes in the knowledge of the use of mineral fiber thermal insulating cement are reflected in the specification.

Asbestos-Cement Products

Standard Specification for Flat Asbestos-Cement Sheets (C 220–55)

Tentative Revision.—The provisions of the specification have been expanded to cover sheets of ¼ and ⅛-in. thicknesses.

Petroleum Products and Lubricants

Tentative Specification for Fuel Oils (D 396–48 T)

Revised.—There is now provided in the specification a sharper delineation between grades 1 and 2 burner fuel oils, and a narrower range of acceptable quality for the No. 2 grade. Committee D-2 feels this will result in fewer adjustments to existing fuel oil burners in order to maintain good burning efficiency and will also assist in the development of new and improved fuel oil burners.

Tentative Methods of Test for Thermal Stability of Aviation Turbine Fuels (D 1660–59 T)

Revised.—The revision removes the variables from the present procedure in reporting thermal stability of aviation turbine fuels where the operator is required to hold the preheater tube at an angle of approximately 45 deg, by requiring that the preheater tubes be compared in a "tuberator" that holds the tubes at a fixed angle and under fixed conditions of light.

Tentative Classification of Diesel Fuel Oils (D 975–59 T)

Revised.—The calculated cetane index which appears as Appendix II of the specification has been brought into conformance with the cetane numbers obtained in the cetane test engine in accordance with the Method of Test for Ignition Quality of Diesel Fuels by the Cetane Method (D 613).

Metallography

Tentative Methods for Estimating the Average Grain Size of Metals (E 112–58 T)

Revised.—There has been added to Table IV (Macro-Grain Size Relationships) information on average intercept distance (inches) and average intercept distance (millimeters). In Section 9 on numerical expression of grain size, a new paragraph (*b*) has been added, the present paragraph (*b*) being relettered as (*c*).

Recommended Practice for Determining the Inclusion Content of Steel (E 45–51)

Revised and Reverted to Tentative.—With more exacting demands on the cleanliness of steel and the new processes developed for steel making such as vacuum melting, the industry finds it necessary to eliminate the confusion developed in examining such steels by different methods. The revision is directed toward this end.

Metallic Materials for Thermostats and for Electrical Resistance, Heating, and Contacts

Tentative Method of Test for Mechanical Torque Rate of Spiral Coils of Thermostat Metal (B 362–60 T)

New Tentative.—This method has been developed particularly to cover the testing of the mechanical torque rate of spiral coils made of thermostat metal for carburetors and manifold heat controls. The method is not limited to thermostat metals and can be used for spiral coils of other materials for which the torque rate must be measured accurately.

Fire Tests of Materials and Constructions

Tentative Methods of Test for Measuring the Surface Flammability of Materials Using a Radiant Heat Energy Source (E 162–60 T)

New Tentative.—This standard fills a long-time need for test methods involving small scale specimens and apparatus for research and development purposes. It is not intended for use as a basis of ratings for building code purposes.

Tentative Methods of Fire Tests of Window Assemblies (E 163–60 T)

New Tentative.—These methods provide a needed standard procedure for conducting tests of window assemblies for use in wall openings which will register performance during fire exposure and provide data to enable regulatory bodies to determine their suitability where fire protection is required.

Tentative Method of Test for Surface Burning Characteristics of Building Materials (E 84–59 T)

Revised.—Refinements have been made in the procedure and apparatus as a result of cooperative tests. The revised method conforms with Standard 255 of the National Fire Protection Assn., and Underwriters' Laboratories Standard UL 723.

Materials for Electron Tubes and Semiconductor Devices

Tentative Specification for Mica Bridges for Electron Tubes (F 12–60 T)

New Tentative.—A major item of simplification accomplished by this specification is the designation of thickness ranges for mica used as insulating spacers in electron tubes. This is of special interest as regards importation of mica.

Tentative Specifications for Disk Cathode Assemblies (F 13–60 T)

New Tentative.—These specifications cover planar disk cathode assemblies of various types and sizes primarily for use in cathode ray tubes such as television picture tubes. The three-piece assembly consists of a nickel shank, nickel cap, and ceramic insulator. Measurement of dimensions of these assemblies is critical in the applications, and this specification is needed to clarify the measurement procedure.

Electrical Insulating Materials

Tentative Methods of Testing Vitrified Ceramic Materials for Electrical Applications (D 115–59 T)

Revised.—Sections 13 to 16 covering the test for effect of heat on flexural strength have been deleted, since it had been determined that the test is no longer useful.

Tentative Methods of Sampling and Testing Untreated Paper Used for Electrical Insulation (D 202–55 T)

Revised.—A 60-cycle dissipation factor and dielectric constant test for dry capacitor tissue has been added. Power loss in the dielectric of a-c capacitors is important in their design and application; it has been found that this loss is largely associated with the capacitor tissue. There has been added a test method for surface friction of paper, since the dynamic coefficient of friction of paper is found to be affected by composition and structure of the paper. A knowledge of the paper-to-paper and paper-to-metal frictional characteristics is useful in the manufacture and application of electrical insulating papers. Sections 5 to 9 on thickness have been revised to bring the method in line with best modern practices.

Tentative Specification for Electrical Insulating Paper—Interlayer Type (D 1305–54 T)

Revised.—The specification has been completely revised to bring it up-to-date.

Tentative Specification for Natural Muscovite Mica Based on Visual Quality (D 351–57 T)

Revised.—At the request of importers of mica, there has been a reduction in severity and restrictiveness of the requirements for stained A quality mica.

Soils for Engineering Purposes

Tentative Definitions of Terms Relating to Soil Dynamics (D 1707–60 T)

New Tentative.—Soil dynamics comprises a multiple of overlapping fields such as soil statics (-mechanics), geology, geophysics, seismology, seismometry, acoustics. It has been quite difficult to find a common denominator that satisfies the terminologies of all these numerous long-established sciences. It is believed that publication of these tentative definitions will aid in resolving differences.

Emission Spectroscopy

Tentative Recommended Practice for Describing and Specifying the Excitation Source in Emission Spectrochemical Analysis (E 172–60 T)

New Tentative.—An essential part of methods for emission spectrochemical analysis is the description and specification of the excitation source. This recommended practice provides general recommendations for the description of the various types of sources used in spectrographic analysis and for the specification of source parameters.

Tentative Definitions of Terms Relating to Emission Spectroscopy (E 135–60 T)

Revised.—A number of terms have been added in order to provide standardized nomenclature in emission spectroscopy.

Clay Pipe

Tentative Specification for:

Standard Strength Ceramic Glazed Clay Pipe (C 462–60 T)

Extra Strength Ceramic Glazed Clay Pipe (C 463–60 T)

New Tentatives.

Tentative Specification for:

Standard Strength Ceramic Glazed or Unglazed Clay Sewer Pipe (C 261–57 T)

Extra Strength Ceramic Glazed or Unglazed Clay Pipe (C 278–57 T)

Revised.—Specifications C 261 and C 278 have been revised by the removal of the provisions covering ceramic glazed clay pipe which are now published as new tentative Specifications C 462 and C 463. This action was recommended by Committee C-4, since ceramic glazed and unglazed pipes are distinctly different in structure and physical qualities, and it was considered unfair to the engineers using the standards to have to consider them as equal. A further revision of Specification C 278 is the addition of sizes 27- and 33-in. pipe to accommodate present trade practice.

Standard Methods of Testing Clay Pipe (C 301 – 54)

Revised and Reverted to Tentative.—The manufacture of longer lengths of pipe especially in the larger sizes has necessitated a revision of these methods to provide the appropriate procedure to accommodate the new lengths.

Tentative Specification for Vitrified Clay Pipe Joints Using Materials Having Resilient Properties (C 425–58 T)

Revised.—The revision provides improvement and greater refinement in the specification which have been found necessary with its use since publication in 1958.

Adhesives

Standard Definitions of Terms Relating to Adhesives (D 907–55)

Tentative Revision.—Definitions have been added for cobwebbing, cottoning, feathering, mastic, body, and throwing.

Rubber

Tentative Definitions of Terms Relating to Rubber and Rubber-like Materials (D 1566–58 T)

Revised.—Tentative definitions have been added for rubber and rubber products.

New Time, Place for Symposium on Electron Device Processing

LOCATION AND DATES for the three-day Symposium on Materials and Electron Device Processing, announced in the September BULLETIN, have been changed. The meeting, sponsored by Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, will be held April 5–7, 1961, at the Benjamin Franklin Hotel, Philadelphia, Pa.

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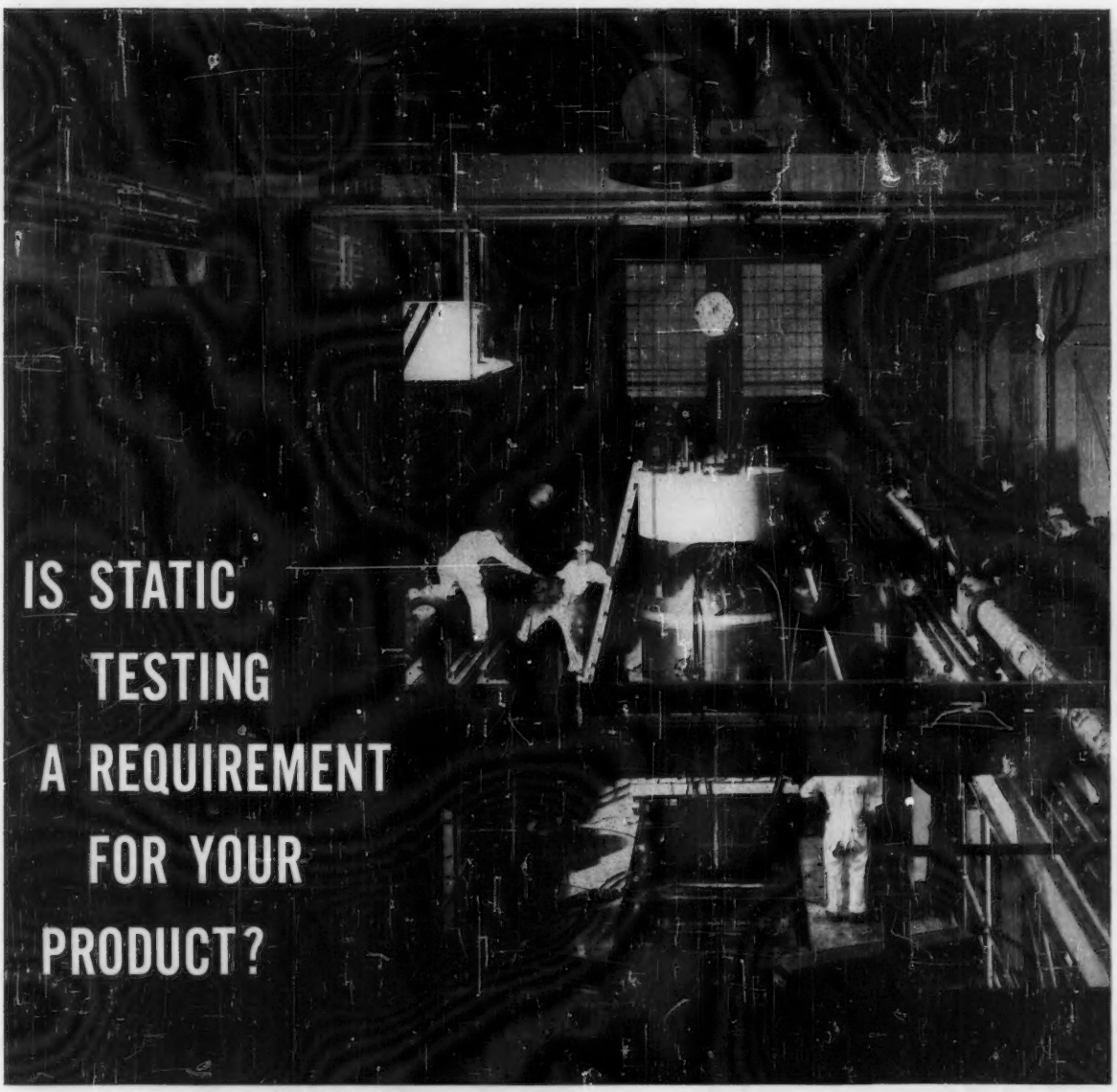

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Bookshelf

Radiations and Matter

Andre´ Berthelot; Leonard Hill Ltd. (1958); 180 pp.; 25 s. net.

Reviewed By J. B. Trice, General Electric Co. Cincinnati, Ohio.

Radiations and Matter is a translation by F. R. Paulsen, consultant editor of *Atomics and Nuclear Energy*, and André Berthelot's *Rayonnements de particules atomiques, electrons et photons*. The English translation, fortunately retains the spirit and color of a treatise which organizes and presents effectively the basic physics of charged-particle interactions with matter. Although the language and style would appeal particularly to physicists, M. Berthelot speaks to everyone who wishes to understand such effects. The mathematical demands on the reader are mild—a passing acquaintance with calculus will suffice; however, there is an element of sophistication that does not clearly reveal itself at first. A careful reading, however, discloses that a clear review of the first part is prerequisite to a full appreciation of the later sections on fission-fragment slowing down and effects from electrons and photons.

Books reviewed here are furnished by publishers knowing of the broad interests of ASTM. Occasionally reviews are prepared by ASTM Staff members, but in most cases, the books are reviewed by Society members or other individuals who are well informed on the subject at hand. Members who wish to be considered for reviewing books are invited to send in their names and the subjects in which they are interested Due to customs and mailing considerations, requests from the United States only can be considered.

Copies of these books are not available through ASTM; all inquiries concerning them should be addressed to the publisher.

The book opens with a few general comments regarding the energy and geometry of two-body systems of colliding particles. Relationships between incident energies and final energies are derived, as are relative deflection angles for the two particles after collision.

The treatment of mathematical derivations is adequate, save for a few apparently typographical errors, easily corrected if the reader wishes to derive each equation step-by-step. The author could have profited his readers by emphasizing the significance of certain quantities such as the energies of incident and struck particles. Also, the transition from center of mass to laboratory coordinates may appear mysterious to one who has not come to grips with the "billiard-ball" problem for some time. Reference to a good mechanics text can easily resolve such difficulties. The discussion of impact parameter, or distance of closest approach, and its relation to effective cross section is lucid and excellent.

After three chapters of preliminaries, the author launches into the essence of the book—a quantitative discussion of the behavior of charged particles in matter. He begins with a discussion of the slowing down of protons. Experiments of T. Hall which revealed how protons from 20 to 400 kev are transmitted or captured in metals such as beryllium, aluminum, silver,

(*Continued on p. 68*)

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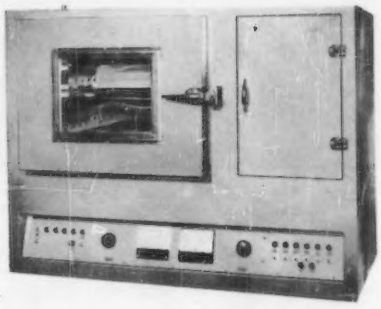

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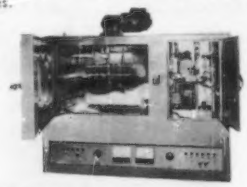

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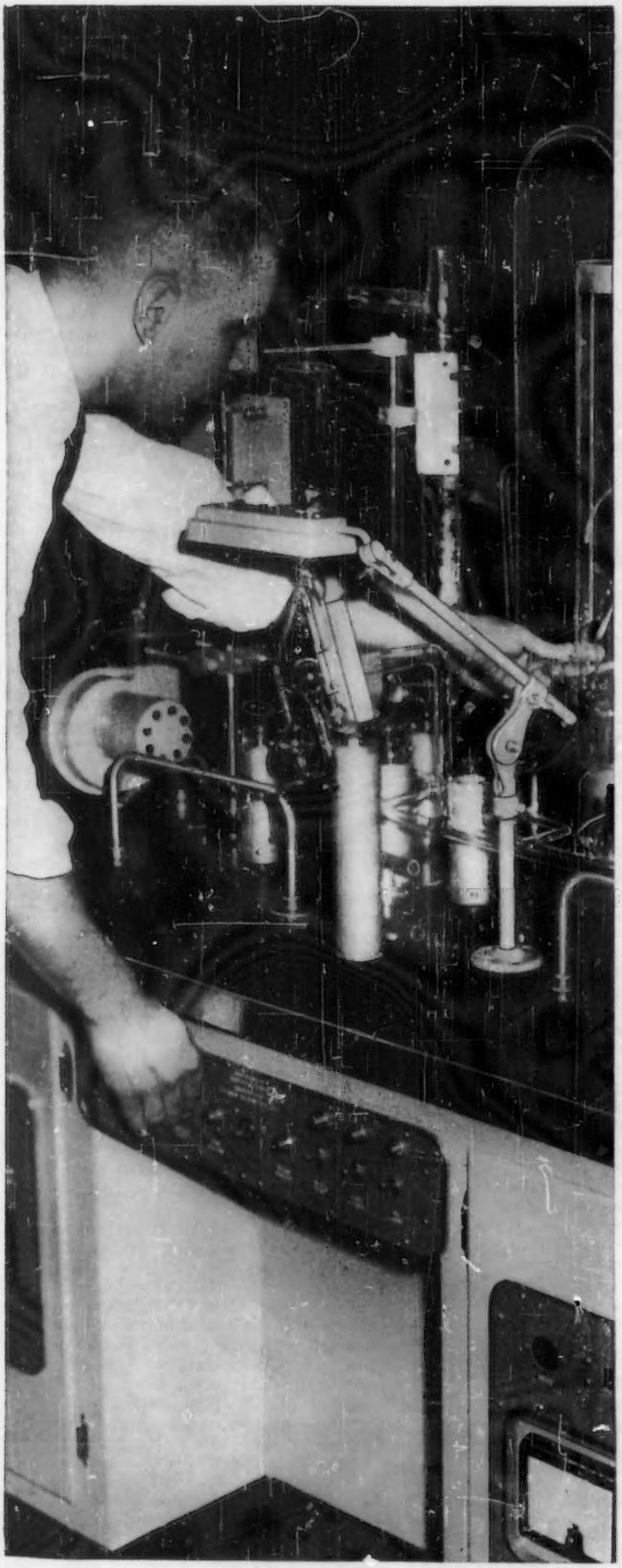

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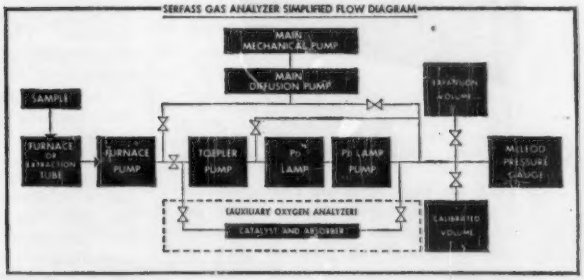

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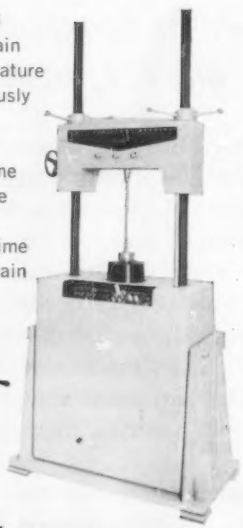

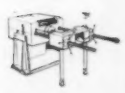

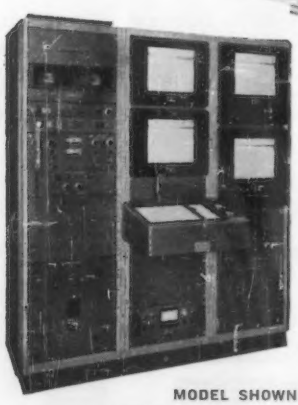

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BOOKSHELF

(*Continued from p. 66*)

and gold are described to show that to a first-approximation cross-section is independent of medium and that it depends only on proton velocity.

Experiments with alpha particles are described next, and it is shown, through some very clever experiments, how equilibrium charge varies with energy and velocity during slowing down. The assimilation of knowledge of particle-matter interaction behavior as described and illustrated here could be of great help to a student or research scientist seeking to learn mechanisms of radiation effects. The discussion of alpha particles serves as an introduction to the subject of light atoms and how they are decelerated. Theoretical curves showing the relation between energy and atomic stopping power divided by atomic number are compared with experimentally obtained curves. Range versus energy, straggling relations, and ionization along particle path length are analyzed.

Throughout all of the discussion, explanation is strikingly annotated with many specific experiments, including cloud chambers, bombardment of foils, differential ionization measurements, and analysis of tracks in photograph emulsions.

Although the chapter that discusses the slowing down of fission fragments is short, it is the high point of the entire book. Here the author explains how measurements were made to determine both the range and the variation of effective charge on fission fragments in several different media. Thus, at this point, we are given the basis for understanding displacement phenomena and radiation damage. The material preceding this chapter is pointed toward understanding the complex kinetics of heavy charged-particle interaction with matter. The discussion of fission neatly completes the picture.

Three chapters following the one on fission concern electrons and photons and, as in the preceding chapters, the principal subject is slowing-down phenomena. The profusion of experimental description and the supporting references save the remainder of the book from becoming a rehash of these two classic subjects.

The most important single aspect of the book is the marshalling of the dozens of experiments to support a single theme—the understanding of the behavior of charged particles as they lose their energy in matter. Graduate students doing research in particle physics or radiation effects will be able to refer profitably to many of the experiments described; teachers will value the book as a supporting reference text for graduate courses in modern physics or chemistry; mature researchers will find the book to be a valuable library addition.

Stabilization of Radicals at Low Temperatures

National Bureau of Standards Monograph 12, edited by Arnold M. Bass and H. P. Broida; (1960); 110 pp., $1.50.

Reviewed by George Adler, Brookhaven National Laboratory.

THIS LITTLE volume is just what its subtitle says it is, a "Summary of the NBS Program" on the stabilization of free radicals. What makes it interesting is that the National Bureau of Standards program has covered many aspects of the problem and has been responsible for a large share of the published work in this field during the three years in which it was active. A well-conducted summary, therefore, can be expected to have some of the features of a survey of the field.

The monograph is divided into ten sections. The first eight of these are survey papers that were delivered at the Fourth International Symposium on Free Radical Stabilization held in September, 1959. These papers, except for some very minor changes, appear as they did in the proceedings of this conference. The ninth section is a rather good summary of the symposium by M. W. Windsor. The tenth is a bibliography that, unfortunately though understandably, contains only the Bureau of Standards papers. These are listed by year of publication rather than by subject matter. The only index is an author index which refers only to the Bureau of Standards bibliography.

The first section, by James W. Moyer, describes the organization and purpose of the NBS program. It forms an interesting enough preface. The second section, by C. M. Herzfeld and M. D. Scheer, is titled "Qualitative Comments on the Physical and Chemical Processes in Trapped Radical Systems." It is only a page and a half long and forms an inadequate introduction to the substance of the volume. The remaining sections taken together are a good, though short, survey of the subject. Except for the sixth paper, they all contain adequate and up-to-date lists of references. The work cited is so recent that a large fraction of it is as yet unpublished.

The format of the book leaves something to be desired. The wisdom of publishing something which is, after all, only a part of the Proceedings of the Fourth International Symposium on Free Radical Stabilization may be questioned. The lack of an index is regrettable. These matters, however, are understandable when the book is considered as the final report of a government-sponsored project. Considered as a whole, this little volume forms a good starting point for someone who is entering the field and is looking for a short introduction with a reasonable list of references.

(*Continued on p. 78*)

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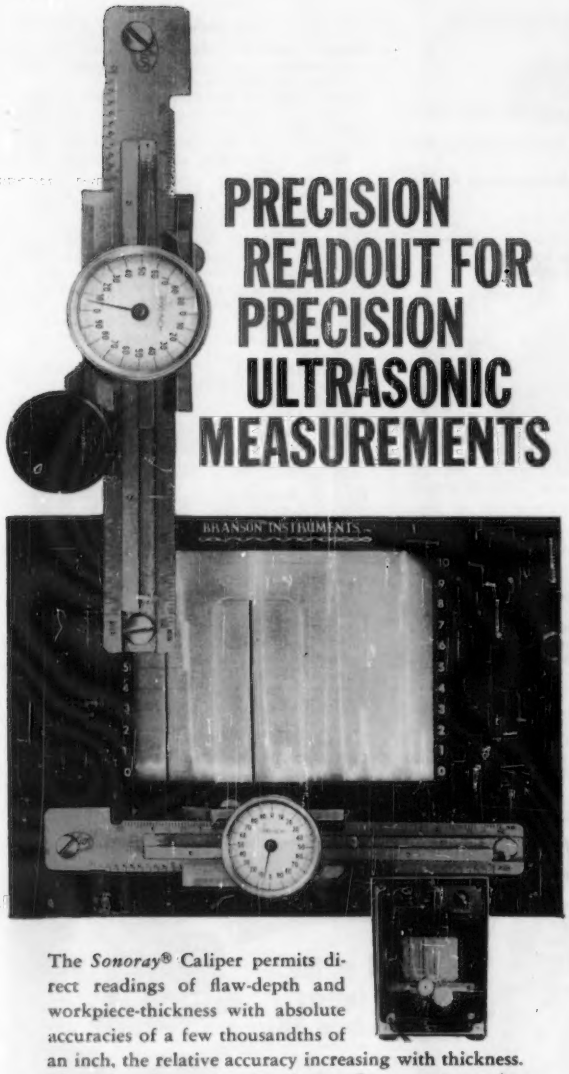

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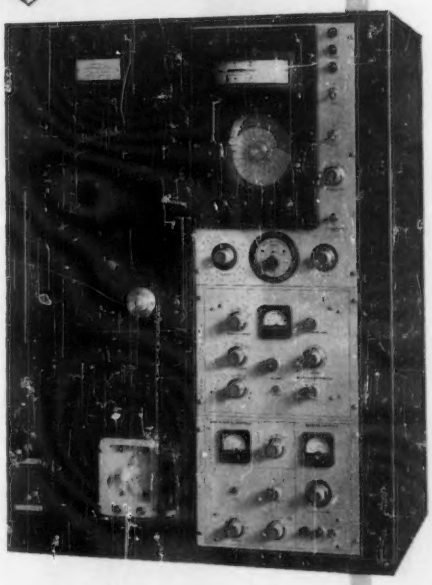

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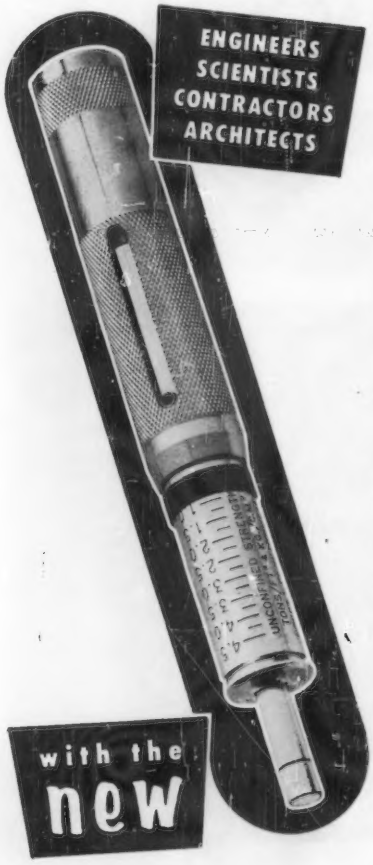

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(*Continued from p. 68*)

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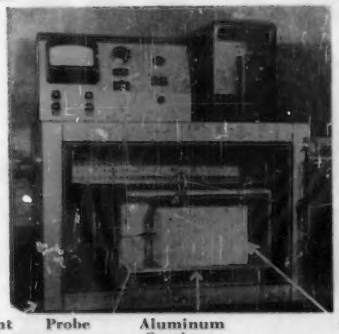

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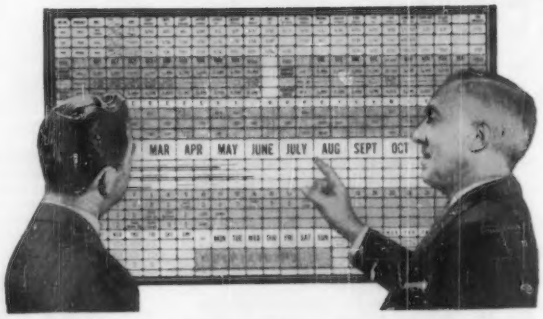

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NEWS OF MEMBERS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

At the American Society for Civil Engineers' convention in October several ASTM members were honored. **Earle T. Andrews,** vice-president, Pennsylvania Glass Sand Corp., Hancock, W. Va., was elected the director for District 6; and **Harmer E. Davis,** professor of civil engineering and director, Institute of Transportation and Traffic Engineering, University of California, was elected the director for District 11. **Solomon C. Hollister,** dean, College of Engineering, Cornell University, was elected to honorary membership. **H. Bolton Seed,** assistant professor of civil engineering, University of California, Engineering Materials Laboratory, and **Clarence K. Chan,** Institute of Traffic and Transportation Engineering, University of California, received the J. James R. Croes Medal for their paper on "Thixotropic Characteristics of Compacted Clays." **F. E. Richart, Jr.,** associate professor of civil engineering, University of Florida, was the winner for the second consecutive year of the Thomas A. Middlebrooks Award, for his paper entitled "Review of the Theories for Sand Drains." **Othmar H. Ammann,** consulting engineer, Ammann & Whitney, New York, N. Y., was the recipient of the Ernest E. Howard Award "for design and construction of outstanding bridges of record dimensions, and large engineering works, including the George Washington Bridge, the Lincoln Tunnel under the Hudson River, and the Narrows Bridge now under construction at the entrance to the New York Harbor."

Ludwig Adams has joined the Virginia Erection Corp., Pittsburgh, Pa., as assistant to the president. Previously he was staff associate, development and research, Blaw-Knox Co., Pittsburgh, Pa.

George H. Ashley is associated with Raeford Worsted Plant, Pacific Mills, Burlington Industries, Inc., Raeford, N. C., as technical superintendent. Formerly he served in the same capacity for McCormick Mills, McCormick, S. C.

Eugene C. Bernett has joined Jet Propulsion Laboratory, Pasadena, Calif., as research specialist. He had been metallurgical and physical group engineer, The Marquardt Corp., Van Nuys, Calif.

Charles W. Blacketer, previously technical director, Revilo Paint and Varnish Co., Kansas City, Mo., is now technical sales representative, Peerless Lacquer and Chemical Co., St. Louis, Mo.

Herman P. Briar is with Aerojet-General Corp., Solid Rocket Plant, Sacramento, Calif. Formerly he was a chemist with The Dow Chemical Co., James River Div., Williamsburg, Va.

Eldridge K. Camp, previously staff engineer, International Business Machines Corp., Poughkeepsie, N. Y., is now director of research and development, American Chemical and Refining Co., Waterbury, Conn.

Louis Campagnoli, formerly with United Clay Mines Corp., Trenton, N. J., is now a consultant, East Brunswick, N. J.

Simon Collier, a consultant in New Rochelle, N. Y., since his retirement from Johns Manville Co., has received the first George D. Edwards Medal, from the American Society for Quality Control. This honor was accorded him for "outstanding leadership in the American Society for Quality Control and in the practical use of modern methods of quality control, especially by application procedures, or by the organization and administration of quality control work." Mr. Collier has been a pioneer in the development of better knowledge of the significance of quality control and was active in the establishment of ASQC. He is currently serving as chairman of Committees D-11 on Rubber and Rubber-like Products and E-11 on Quality Control of Materials, is a former national director, and in 1956 received the ASTM Award of Merit.

Richard L. Davis is associated with Miller-Warden Associates, Swarthmore, Pa. Previously he was North Carolina manager, Emulsified Asphalt Refining Co., Raleigh, N. C.

Edward K. Davison, president of J. K. Davison & Brothers, Pittsburgh, Pa., was recently elected president of the National Sand and Gravel Assn.

Norman P. Dyck is associated with General Electric Co., Missiles & Space Vehicle Dept., Philadelphia, Pa., as materials and process engineer. Previously, he was development chemist, Curtiss-Wright Corp., Curon Div., Quehanna, Pa.

C. L. Eksergian is now director of engineering, Heintz Div., Kelsey-Hayes Co., Philadelphia, Pa. Formerly he was vice-president, engineering, Automotive Div., The Budd Co., Detroit, Mich.

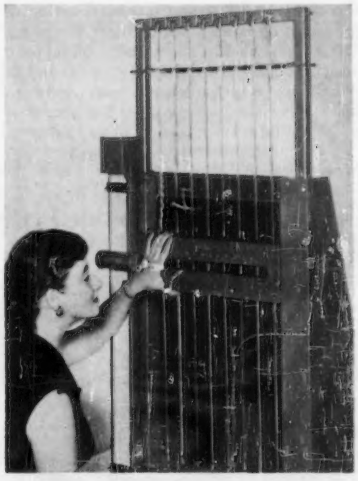
Benjamin Fitzpatrick, prior to becoming the owner of Threaded Products, Inc., Pittsburgh, Pa., was assistant manager, Penn Bolt and Nut Co., McKees Rocks, Pa.

Eldon Lloyd Fowler, formerly manager, Materials Testing Laboratories, Ltd., Edmonton, Alta., Canada, is now associate professor of civil engineering, University of Alberta, Edmonton, Alta., Canada.

J. H. Foote, chief engineer, Commonwealth Associates, Inc., Jackson, Mich.,

(*Continued on p. 76*)

FASTER, EASIER WAY to determine petroleum hydrocarbon types by the F-I-A method



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CIRCLE 847 ON READER SERVICE CARD

NEWS OF MEMBERS

(*Continued from p. 75*)

long-time member and committee officer of ASTM, was honored by the American Standards Assn. recently by receipt of the Howard Coonley Medal. This is awarded to the person who has shown outstanding leadership in the practical application of standards. Mr. Foote is a former national director of ASTM and has been active in various technical committees, including B-1 on Wires for Electrical Conductors, which he headed from 1938 to 1950 and of which he was secretary from 1934 to 1938. He has just completed a period of outstanding service to ASTM as chairman of the Administrative Committee on Standards.

Leon V. Foster, head, Military Engineering Dept., Bausch & Lomb Optical Co., Rochester, N. Y., retired recently. Dr. Foster joined ASTM in 1932.

John R. Freeman, Jr., vice-president, metallurgy and research, The American Brass Co., Waterbury, Conn., and past director of ASTM retired October 1, 1960. He has been an individual member of the Society since 1920 and represented his company's sustaining membership for many years. Mr. Freeman's technical committee activities were many, his main interest being in the non-ferrous field.

William J. Hart is now associate professor of chemistry, Tennessee Polytechnic Inst., Cookeville, Tenn. He has been associate professor, Maryland State College, Princess Anne, Md.

E. O. Hausman, vice president, Continental-Diamond Fibre Corp., Newark, Del., has been elected chairman of the Manufactured Electrical Mica Section of the National Electrical Manufacturers Assn.

Victor Hicks, formerly chief physicist for the Allen-Bradley Co., Milwaukee, Wis., has joined the Remington Rand Univac Military Dept., Univac Park, St. Paul, Minn.

Arthur H. Johnson, previously director of research, American Bowling Congress, Milwaukee, Wis., is vice-president, Bowl Mor Co., Inc., Littletown, Mass.

A. S. Kidwell is now research associate, Applications Research Dept., Olin Mathieson Chemical Corp., New Haven, Conn. Formerly, he was manager, research and development, The Connecticut Hard Rubber Co., New Haven, Conn.

W. J. Kiernan, Bell Telephone Laboratories, Murray Hill, N. J., and one of the ASTM delegates to the Inter-Society Color Council has been elected vice-president of the Council.

William H. Klein, vice-president, Dragon Cement Co. Div. of American-Marietta Co., Northampton, Pa., retired October 1, 1960. Mr. Klein is a 50-year member of the Society, and has served on Committee C-1 on Cement since 1916.

Jack D. Lubahn is now professor of mechanics, University of Wisconsin, Madison, Wis. Formerly, he was mechanics of materials engineer, General Electric Co., Knolls Atomic Power Laboratory, Schenectady, N. Y.

Charles W. MacGregor is an engineering consultant, International Business Machines, Endicott, N. Y.

L. J. Markwardt, retired assistant director, U. S. Forest Products Laboratory, Madison, Wis., honorary member and past-president of ASTM, has been named one of the vice-presidents of the International Wood Research Soc. recently launched in Paris under the auspices of the United Nations Food and Agriculture Organization.

A. F. Matson, managing engineer, Chemical Dept., Underwriters' Laboratories, Chicago, Ill., retired after 41 years. Mr. Matson has participated in committee activities since 1934, having served on Committees D-11 on Rubber and Rubber-Like Materials, D-20 on Plastics, D-2 on Petroleum Products and Lubricants, and A-5 on Corrosion of Iron and Steel

Louis Mittelman, chief chemist, Tidewater Oil Co., Associated Div., Associated, Calif., retired October 31, 1960. Since he joined the Society in 1927, Mr. Mittelman has been active in committee work, having served on Committees D-2 on Petroleum Products and Lubricants, D-9 on Electrical Insulating Materials, and D-22 on Methods of Atmospheric Sampling and Analysis.

Herbert McClammy is now engineer in charge, research and development, Gibbs Corp., Jacksonville, Fla. Previously, he was consulting engineer, Reynolds, Smith & Hills, Jacksonville, Fla.

Howard K. Nason, vice-president and general manager, Research and Engineering Div., Monsanto Chemical Co., St. Louis, Mo., has been named president of Monsanto's new company, Monsanto Research Corp. The new company will centralize control of existing governmental research activities and act as a vehicle for renewed efforts to win government research contracts. **Erwin G. Somogyi,** research director, Inorganic Chemicals Div., was elected a vice-president and appointed general manager of the Research and Engineering Div., succeeding Mr. Nason.

Ralph P. Nevers, Anaconda American Brass Co., Waterbury, Conn., retired the end of October. Mr. Nevers represented his company on Committees B-2 on Non-Ferrous Metals and Alloys, D-19 on Industrial Water, E-3 on Chemical Analysis of Metals, E-4 on Metallography, and Sub 15 of E-1 on Methods of Testing.

Daniel I. Nitzberg, formerly in materials in standards engineering, Minneapolis-Honeywell Regulator Co., Beltsville, Md., is now with the Martin Co., Baltimore, Md., as materials engineer.

Francis T. P. Plimpton, Jr., former assistant technical editor, *The Iron Age*,

(*Continued on p. 78*)

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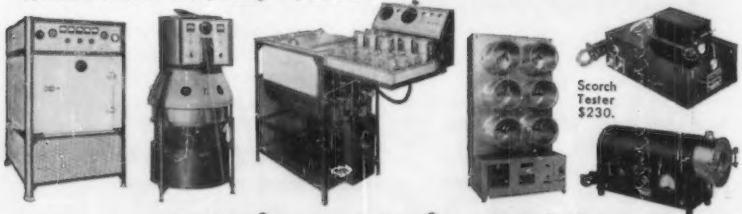

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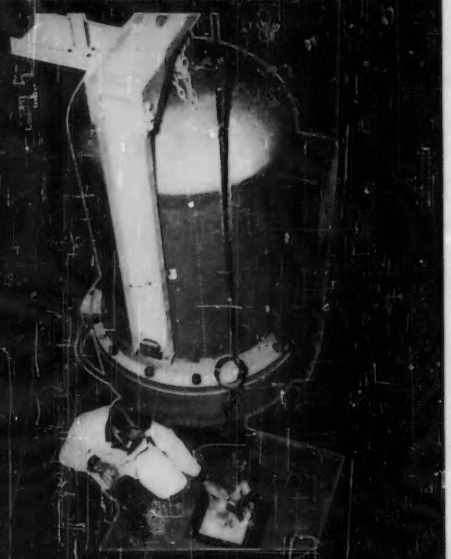
- Penetration: 2" to 8"
- Equivalent steel thickness
- Mount Options: Fixed, truck, or flexible crane

Performance Characteristics

Model	Energy (Mev)	X-Ray Intensity 1 meter from source (r/min)	Focal Spot (mm)
JR	1	8	1
AR	2	75	3



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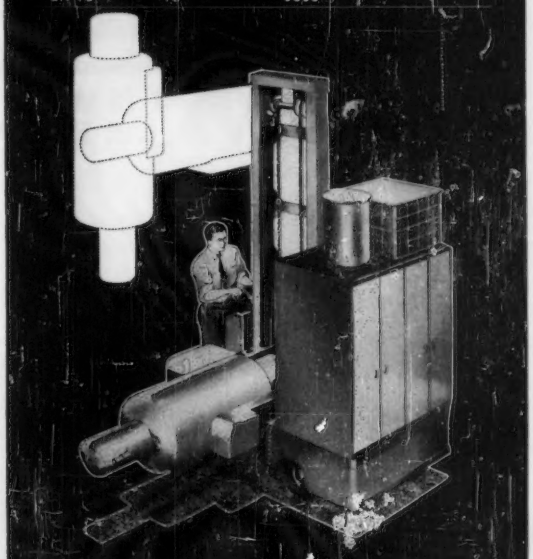
LR-8*	8	1500-6000	1-5
LR-12	12	2300-8000	1-8
LR-15*	15	3000	



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NEWS OF MEMBERS

(*Continued from p. 76*)

Philadelphia, Pa., is now general manager, Talman Corp., W. Warwick, R. I.

Andrew Pocalyko has joined E. I. du Pont de Nemours and Co., Inc., Gibbstown, N. J., as research engineer. He had been staff metallurgist, Aeroprojects, Inc., West Chester, Pa.

Melvin G. Quayle is vice-president, sales, American Gypsum Co., Albuquerque, N. Mex. He was technical service manager, Zonolite Co., Chicago, Ill.

Bernard R. Queneau has received an award of nearly $2000 for his part in a process for nucleating steel ingots, now patented by the U. S. Steel Corp. Sharing in the award with a similar check was Dennis J. Carney. Dr. Queneau is assistant manager of metallurgy, inspection, and research at U. S. Steel's Tennessee Coal and Iron Div. Dr. Carney is assistant general superintendent, Homestead District Works, Homestead, Pa.

Thomas G. Reynolds has joined the engineering staff of SunOlin Chemical Co., Philadelphia, Pa., as project manager.

Robert L. Schiffman of the department of civil engineering, Rensselaer Polytechnic Inst., Troy, N. Y., has been promoted to associate professor.

Walter G. Schulz, former chief engineer, Division of Design and Construction, California State Department of Water Resources, Sacramento, Calif., is now vice-president in charge of a new San Francisco office of Leeds, Hill & Jewett, Inc.

Paul Schwarzkopf, director of research, Schwarzkopf Development Corp., New York, N. Y., was honored at the International Powder Metallurgy Conference, where he received a plaque from the Metallurgical Society of AIME.

Niles I. Searls is now sales manager, Rhodes & Jamieson Ltd., Oakland, Calif. Formerly he was vice-president, Noble Co., Oakland, Calif.

Theodore W. Selby, senior research chemist, General Motors Research Laboratories, Fuels & Lubricants Dept., Detroit, Mich., received both the Russell S. Springer and Henry Ford Memorial Awards from the Society of Automotive Engineers. The Springer award goes to the youngest author of a technical paper of permanent interest to be accepted and published in SAE *Transactions*. The Henry Ford Award, presented by the Detroit SAE Section, goes to the junior SAE member who writes the best technical paper on ground vehicles in the year.

B. Franklin Shepherd, chief metallurgist, Ingersoll-Rand Co., Phillipsburg, N. J., retired recently. Mr. Shepherd joined ASTM in 1915 and resigned in 1938 during which time he served on Committees A-3 on Cast Iron; A-7 on Malleable-Iron Castings; E-4 on Metallography; and A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys. He rejoined the Society in 1957 and again participated in the activities of Committee A-3 and was member of the Joint Committee on Effect of Temperature on the Properties of Metals.

Philip Sporn, president, American Electric Power Service Corp., New York, N. Y., recently received the first State of West Virginia Americanism Award and Citation because "as head of the American Electric Power Corp., he has developed technological aspects of generating electricity to produce power inexpensively enough to help attract new industries to the State of West Virginia."

Paul H. Stuff, formerly executive vice-president, Ross-Meehan Foundries, Chattanooga, Tenn., has been named president.

Russell L. Vesper, prior to becoming instructor of engineering, Fort Lewis A & M College, Durango, Colo., was assistant forest engineer, U. S. Forest Service, Santa Fe, N. Mex.

H. Fred Waller, Jr., is now salesman, Asphalt Div., Esso Standard, Div. of Humble Oil and Refining Co., Richmond, Va. He had been materials engineer, North Carolina State Highway Commission, Division of Materials, Raleigh, N. C.

(*Continued on p. 81*)

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FOR FURTHER INFORMATION CIRCLE 851 ON READER SERVICE CARD →

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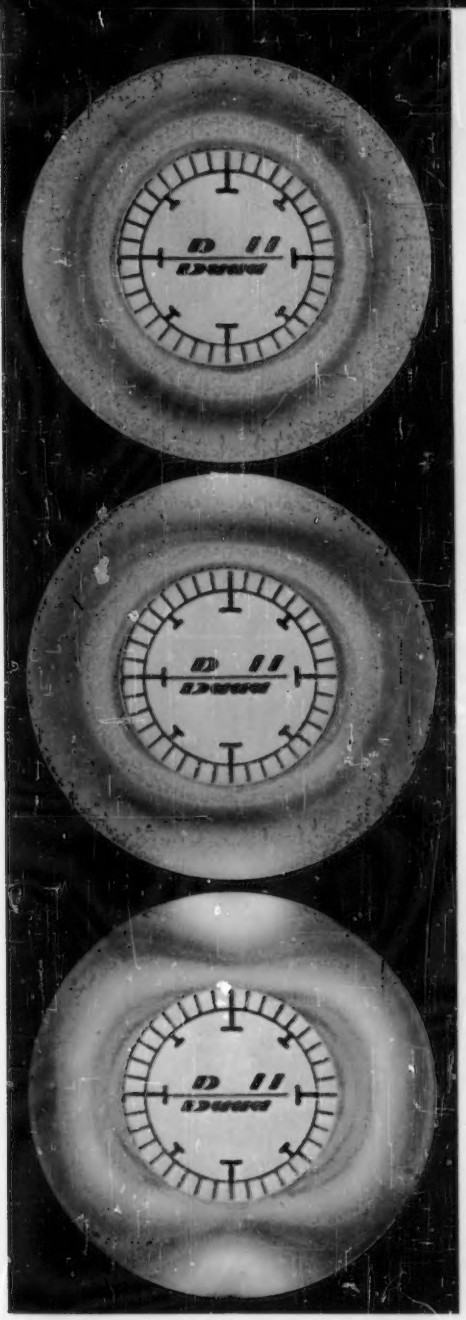

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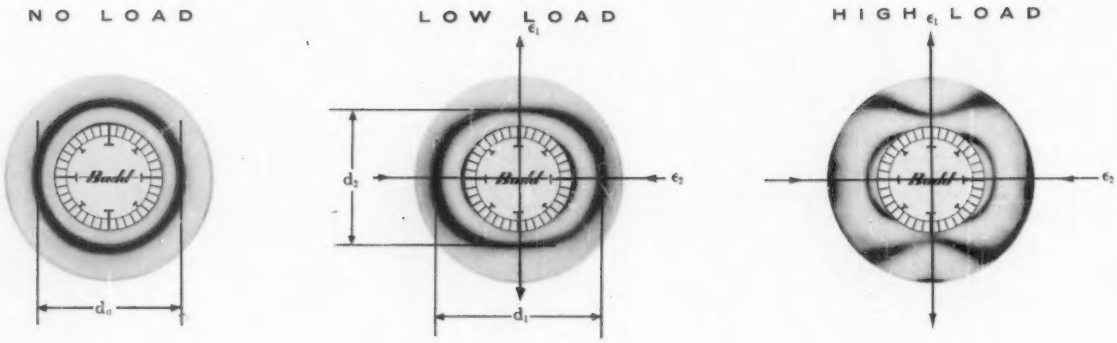

Gages shown actual size. ϵ_1 and ϵ_2 are principal strains.
d_0—diameter of circular fringe for zero strain.
(d_1-d_0), (d_2-d_0) . . . fringe shift along axes of symmetry of pattern, due to strain. Axes of symmetry are principal strain directions.
ϵ_1 is a function of d_1-d_0. ϵ_2 is a function of d_2-d_0.

EXCLUSIVE FEATURES:

- Measurements of principal strain directions possible for strain levels as low as 50 microinch/inch and up.
- Major and minor principal strain directions obviously apparent.
- Separate magnitudes of strains obtained *directly* along desired axis.
- High readout sensitivity due to permanent pattern.
- Constant sensitivity for directions and magnitudes for any strain level.
- Proved PhotoStress technique (Zandman method).

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- Direct readout . . . no instruments or electrical connections.
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- Directions of principal strains: within $\pm 5°$ (with care, better accuracies are possible).
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CIRCLE 852 ON READER SERVICE CARD

NEWS OF MEMBERS

(*Continued from p. 78*)

Samuel E. White has been appointed manager, linoleum operations, Congoleum-Nairn Inc., Trenton, N. J.

Arthur C. Willis, previously senior test engineer, Temco Electronics and Missiles Co., Dallas, Tex., is quality engineer, The Martin Co., Denver, Colo.

DEATHS

Harold F. Clemmer, engineer of materials and standards, District of Columbia Highway Dept., Washington, D. C. (October 5, 1960). Mr. Clemmer became associated with ASTM in 1915, and in the succeeding 45 years he participated in many phases of the Society's work. He was a past-director, a member of Committees D-4 on Road & Paving Materials, C-9 on Concrete and Concrete Aggregates, A-1 on Steel, C-1 on Cement, D-18 on Soils for Engineering Purposes, and a charter member of the Washington, D. C., District Council, which he helped organize. In recognition of his long and effective services the Society presented him with its Award of Merit in 1960.

Clyde A. Crowley, professor of chemistry, Arizona State College, Tempe, Ariz. (September 21, 1960). Professor Crowley had been a member of ASTM since 1941 and was a member of the Rocky Mountain District Council.

J. H. Davidson, TCM/India, U. S. Department of Commerce, Bureau of the Census, Washington, D. C. (August, 1960). Mr. Davidson was a long-time member of Committee E-11 on Quality Control of Materials, and had served as secretary of that committee.

W. F. Farnham, Modjeski & Masters, Harrisburg, Pa. (March 22, 1960). Mr. Farnham was a member of the Joint Committee on Filler Metal.

E. F. Fernes, manager, Boiler and Machinery Inspection Dept., Maryland Casualty Co., Baltimore, Md. (Sept. 9, 1960). Mr. Fernes joined the Society in 1957.

Vernon Franklin, chief chemist, Armour Industrial Chemical Co., Chicago, Ill. (recently). Mr. Franklin represented his company on Committees D-17 on Naval Stores; D-1 on Paint, Varnish, Lacquer and Related Products; and D-16 on Industrial Aromatic Hydrocarbons and Related Materials.

In the death of **Jonathan Jones** (recently), formerly chief engineer of McClintock-Marshall Co., and later chief engineer, Fabricated Div., Bethlehem Steel Co., which absorbed the former company, the Society loses one who contributed greatly to the development of practical specifications for structural and related classes of steel and who was highly respected in ASTM and in nu-

(*Continued on p. 82*)

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CIRCLE 853 ON READER SERVICE CARD

DEATHS

(*Continued from p. 81*)

merous other societies for his wise judgment. In ASTM for upwards of 25 years, he was active in the work of Committee A-1 on Steel, Sub II on Structural Steel, and in this group pioneered the development of an over-all specification supplemented by families of specifications with condensed specific properties for various applications. His work in the construction field was recognized by honorary membership in the American Society for Civil Engineers.

H. W. Ladd, superintendent of materials, Pan American Petroleum Corp., Tulsa, Okla. (September 18, 1960). Mr. Ladd joined ASTM in 1945 and since then was active in Committee A-1 on Steel.

H. R. Redington, specification engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa. (September 1960). Mr. Redington was a member of the Society from 1938 until his retirement in 1956. He represented his company on Committees A-1 on Steel and D-10 on Shipping Containers, and was a member of the Pittsburgh District Council.

John E. Rutzler, associate professor, Physical Chemistry, Case Institute of Technology, Cleveland, Ohio (October 12, 1960). Dr. Rutzler joined ASTM in 1952 and at the time of his death was beginning his second term as chairman of Committee D-14 on Adhesives. In 1953 he suggested organization of a Gordon Research Conference devoted to adhesives and remained active in leadership and participation in the subsequent conferences.

Lester N. Shannon, vice-president, Stockham Valves & Fittings, Birmingham, Ala. (September 29, 1960). Mr. Shannon and his wife were killed in an automobile accident. Mr. Shannon had been a member of the Society from 1928 until his retirement in 1956. He represented his company in Society membership and on Committees A-1 on Steel, A-3 on Cast Iron, and A-7 on Malleable-Iron Castings.

Walter C. Voss, professor emeritus and lecturer, Department of Building Engineering and Construction, Massachusetts Institute of Technology, and consultant, architectural construction and materials, Cambridge, Mass. (November 2, 1960). Professor Voss joined ASTM in 1932 and over the years participated in many ASTM activities. His technical committee work included Committees C-12 on Mortars for Unit Masonry; C-7 on Lime, which committee elected him to honorary membership; E-5 on Fire Tests of Materials and Construction; and E-6 on Methods of Testing Building Constructions. Professor Voss also served on the Administrative Committee on Research, was a member of the New England District Council, and represented ASTM on the National Research Council. He delivered the Marburg Lecture in 1947, and in 1957 received the ASTM Award of Merit.

Two Hardness Testers in a Single Instrument

The new Wilson Rockwell TwinTester combines in one instrument the functions of both a Rockwell and a Rockwell superficial hardness tester. Designed primarily for use in such areas as tool departments, maintenance repair shops and laboratories, the TwinTester offers many outstanding features.

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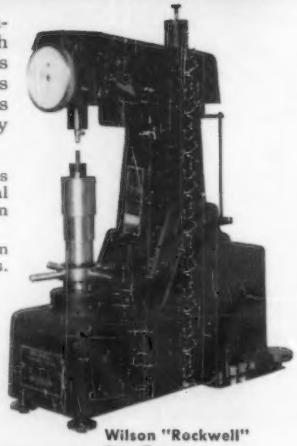
A complete line of Wilson Rockwell instruments is available, including semi and fully automatic models. Wilson "Brale" Diamond Penetrators assure perfect readings every time.

Write for details—Ask for Catalog RT-58. It gives complete information on the TwinTester as well as on the full line of Wilson Rockwell hardness testers.



Wilson "Rockwell" TwinTester

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-C Park Avenue, New York 17, New York

FOR FURTHER INFORMATION CIRCLE 854 ON READER SERVICE CARD

Other Societies' Events

January 9–11—**National Symposium on Reliability and Quality Control;** AIEE, IRE, ASQC, EIA.; Bellevue-Stratford Hotel, Philadelphia, Pa.

January 9–13—**Society of Automotive Engineers,** Annual Meeting and Engineering Display, Cobo Hall and Convention Arena, Detroit, Mich.

January 16–19—**National Limestone Inst.,** Statler-Hilton, Washington, D. C.

January 17–18—**American Society of Lubrication Engineers,** Bearing Symposium, Penn Sheraton Hotel, Pittsburgh, Pa.

January 17–19—**Instrument Society of America,** Conference and Exhibit, Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Mo.

January 17–20—**National Crushed Stone Assn.,** Hotel Americana, Bal Harbour, Fla.

January 23–24—**Industrial Heating Equipment Assn.,** Dearborn Inn, Dearborn, Mich.

January 23–25—**Institute of the Aerospace Sciences,** Annual Meeting, Hotel Astor, New York, N. Y.

January 23–27—**American Mathematical Society,** 67th Annual Meeting, Willard Hotel, Washington, D. C.

January 23–26—**National Sand and Gravel Assn. and National Ready Mixed Concrete Assn. Convention,** Hotel Americana, Bal Harbour, Fla.

January 24–27—**Society of Plastics Engineers,** 17th Annual Technical Conference, Shoreham and Sheraton-Park Hotels, Washington, D. C.

January 29–February 3—**American Institute of Electrical Engineers,** Winter General Meeting, Hotel Statler, New York, N. Y.

February 13–16—**American Society of Heating, Refrigerating, and Air-Conditioning Engineers,** Semiannual Meeting and Exposition, Conrad Hilton Hotel, Chicago, Ill.

February 15 – 17 — **International Solid-State Circuits Conference;** AIEE, IRE, Univ. of Pennsylvania, Philadelphia, Pa.

February 20–23—**American Concrete Inst.,** 57th Annual Convention, The Chase-Park Plaza Hotels, St. Louis, Mo.

February 20–23—**Technical Association of the Pulp and Paper Industry,** 46th Annual Meeting, Hotel Commodore, New York, N. Y.

February 26–March 1—**American Institute of Chemical Engineers,** National Meeting, Hotel Roosevelt, New Orleans, La.

February 26–March 2—**American Institute of Mining, Metallurgical, and Petroleum Engineers,** Annual Meeting, Chase and Park Plaza Hotels, St. Louis, Mo.

February 27–March 1—**Association of Iron and Steel Engineers,** Western Meeting, Hotel Statler, Los Angeles, Calif.

PARR BOMBS

For rapid combustion and fusion reactions with sodium peroxide, and for other laboratory purposes

AC2E **22 ml.**
This is a general-purpose bomb with electrodes for hot wire ignition. It is widely used for determining sulfur, chlorine, phosphorus and other elements in a great variety of combustible organic materials. Furnished with a 94% Ni cup and Ni-plated brass cover. Other cups and covers are available.

A1ACD **22 ml.**
This bomb is the same as AC2E except it has a 5-inch stem for use in the Parr peroxide bomb calorimeter. It is used for measuring heats of combustion, also for chemical analyses following calorimetric tests.

AC4E **22 ml.**
This bomb is similar to AC2E except it has a gas connection for purging with an inert gas. It is used with a Parr 1411 calorimeter for measuring the heats of combustion of thermite and other self-burning pyrotechnic mixtures.

AC3E **22 ml.**
This bomb has a plain cover without electrodes. It is used for sodium peroxide reactions which can be started by heating with a gas torch. Cups of 94% Ni, 36% Ni, 99+% Ni, carbon steel and stainless steel are available.

A116AC **42 ml.**
This bomb is similar to AC-2E except all parts are larger and heavier than in the 22 ml. bomb. It will accommodate samples twice as large as AC2E and AC3E.

A2AC4 **45 ml.**
This bomb is the same as AC3E except the cup is 3⅞" deep to provide a 45 ml. internal volume. Cups of stainless steel, 94% nickel and 99+% nickel are available.

A2AC3 **8 ml.**
This bomb is similar to AC3E except it has a smaller cup with a hemispherical bottom. Sodium peroxide reactions are started by heating with a gas torch. The cup is 94% nickel.

A1MB **2.5 ml.**
This is the smallest of the several Parr peroxide bombs. It has a 94% nickel cup and cover, and is used for treating micro samples.

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Precision-Cut
SLAB
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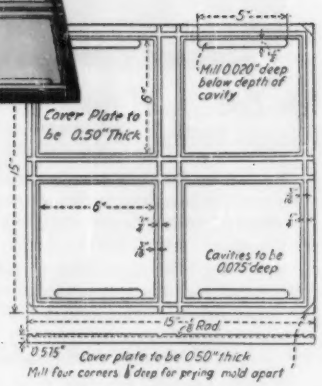
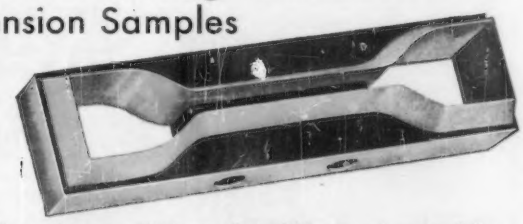

5"
Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
6"
Cavities to be 0.075 deep
15"
0.515"
Cover plate to be 0.50" thick
Mill four corners ⅛ deep for prying mold apart

Dies for Cutting "Dumbbell" Tension Samples



These dies are milled out of steel blocks; edges carefully ground and specially hardened to cut vulcanized rubber. Entire die precision designed to ASTM Standards. For machine use as shown, or with handle for hand operation. Also, hand-forged dies to cut regular or tear test samples.

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A precision laboratory instrument that combines the finest in performance with outstanding appearance. Fast, even heating. Aluminum top plate, stainless steel body. Extra-sensitive thermostat provides stepless regulation with exceptionally close control from room temperature to 370°C (700°F). Cool base and controls. Dovetail sockets at rear. 115 volts a-c. $32.50.

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For heaviest duty jobs, designed especially to stand hard use for prolonged periods. Built with extra strength to support heavy loads. Smooth cast iron top plate. stainless steel body. 4-heat control: L-400°F; LM-535°F; M-710°F; H'930°F (without load). 115 or 230 volts a-c. $45.00.

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BOOKSHELF

(*Continued from p. 73*)

Crystal Structure Analysis

Martin J. Buerger; John Wiley & Sons, Inc., New York, N. Y., (1960); 686 pp.; $78.50.

Reviewed by J. W. Caum, ASTM Staff.

THE METHODS and underlying theory for finding the location of atoms in crystal cells are explained in this volume. The book grew out of notes made while Professor Buerger was instructing students in the study of crystal structure analysis. The reader who has no background in the subject is supplied with the theoretical and methodological equipment for handling specific analytical problems.

Proper procedure for selecting and preparing material, gathering and correcting data, and all the other steps that must be taken before proceeding with the actual analysis are also reviewed in detail. Each chapter ends with an extensive and up-to-date list of references.

The crystal structure analyst will find several topics not included. A development of the Patterson synthesis and vector space are covered in a companion volume, *Vector Space and Its Application in Crystal-Structure Investigation*. Reflection statistics is considered by the author as an advanced and self-contained topic deserving of treatment in a separate volume by an expert in statistics. The subject of optical Fourier transforms, such as the "fly's eye," and their application was omitted because the use of optical analog methods is waning.

Extractive Metallurgy

Joseph Newton; John Wiley & Sons, Inc., New York, N. Y. (1959); 532 pp.; illus.; $9.75.

Reviewed by G. R. Gohn, Bell Telephone Laboratories, New York, N. Y.

THE AUTHOR of this book (now in its second edition) is professor of metallurgy and head, Department of Mining and Metallurgy, University of Idaho. According to the publishers, the book was written primarily as a text for a first course in extractive metallurgy. This reviewer, who is supposedly "one versed in the art," believes that, if the course were offered in the junior year, after the student had taken basic courses in chemistry, physics, solid-state physics, thermodynamics, physical chemistry, and phase rule, the author's book would be an excellent text. If offered earlier in the curriculum, the student would be at some disadvantage in following the various processes, despite the fact that the author devotes somewhat more than half of the book to an extensive summary of the basic principles involved in extractive metallurgy.

The book opens with a discussion of the sources of metals, sampling, and statistics on production and consumption. In logical order chapters follow dealing with ore dressing (comminution, screening, classification, and concentration); chemical principles (stoichiometry, the gas laws, thermochemistry, combustion, chemical affinity, chemical equilibrium, and reaction velocities); solid-state physics and physical metallurgy (including Gibbs phase rule and equilibrium diagrams); and fuels and refractories.

It is some 30 years since this reviewer has studied extractive metallurgy. Hence it is interesting to observe how few really new processes have been developed (such as metallic reduction as used in the Kroll process for the extraction of titanium and zirconium, or vacuum melting as used in the production of magnesium or high-quality steels). However, the author's approach, in which the basic principles are first presented somewhat at length, followed by a brief description of their application to the reduction of ores which can be treated by pyrometallurgical, hydrometallurgical, or electrometallurgical processes, is a much better presentation than the older metal-by-metal approach. The sections in the last three chapters on processes plus the closing chapter on the casting of ingots are quite adequate to give the student the necessary understanding of the problems that may be encountered in extractive metallurgy.

Reactor Handbook (Second Edition), Volume 1, Materials

Edited by C. R. Tipton, Jr.; Interscience Publishers, Inc., New York, N. Y. (1960); 1224 pp.; $36.50.

Reviewed by J. W. Caum, ASTM Staff.

THIS VOLUME is a replacement for *General Properties of Materials, Volume III, The Reactor Handbook* which was published by the Atomic Energy Commission in 1955. Treatment of nearly all topics has been expanded and brought up to date, and many new topics have been added. The expansion reflects not only the dramatic growth of the literature but also the very substantial declassification of nuclear data that has taken place during the past five years.

The coverage has been extended to include liquids and gases as well as solids, which were the only materials treated in the original volume. Information on irradiation behavior, generally unavailable for the first handbook, is now included. Thousands of technical papers, reports, books, and the proceedings from two international conferences on atomic energy have become available and served as additional sources and reference material.

Approximately 130 reactor scientists and engineers have contributed their writing efforts. In contrast to the earlier work in which the policy was to minimize referencing, this book is extensively referenced to make it more useful.

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note. This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

NEW LITERATURE

Adjustable Frames—New frames which are adjustable through the use of socket members are available. The frames are variable not only for height but also for angle for use with manhole covers. Literature available.
Adjust-a-frame Corp. 6334

Fluorescent Compounds—A new 19-page publication listing several hundred compounds exhibiting fluorescent characteristics is now available as a guide to identifying solutions through their fluorescent properties.
American Instrument Co., Inc. 6335

Photometer—The multilayer interference filter recently introduced as a standard component in a flame photometer is fully described in the six-page brochure now available. This improved dielectric filter has a band-width of less than 8 mμ peak transmittance of 70 to 85 per cent, and a rejection factor of more than 99.9 per cent.
Baird-Atomic, Inc. 6336

Instrument Catalog—A new 24-page catalog listing the complete Bruel & Kjaer line of integrated instruments for automatic measurement of sound, vibration, and strain is available.
B & K Instruments, Inc. 6337

Vacuum Gages—New 32-page booklet describes instruments for measuring high-vacuum gages.
Consolidated Vacuum Corp. 6338

Weighing System—Combining scales with calculators and other equipment through use of a binary code, provides a new low-cost semi-automated weighing system for process, quality, and cost control. The basic weight classification system is described and illustrated in *Bulletin 3347-A.*
The Exact Weight Scale Co. 6339

Vacuum Equipment—*Bulletin FC-5* illustrates and describes a complete line of precision glass and glass-metal components, sapphire-to-glass seals, infrared sensing components, precision-bore glass tubing, vacuum thermocouples, vertical sensing and reference levels, and the full line of Televac vacuum measuring instruments for the pressure range from atmospheric to 10^{-10} mm Hg. Includes electrochemical glass products and microminiaturized glass components of all types used in science, industry, and space technology.
The Fredericks Co. 6340

Laboratory Ware—An 8-page booklet which describes, illustrates, and prices more than 125 items of stainless steel laboratory ware has been issued. Designated No. 3–60, the bulletin includes a data table giving corrosion resistance of 18–8 type 302 for more than 180 corrosive chemical substances.
The Harshaw Chemical Co. 6341

Color Meter—Four-page folder describes color-difference meter, gloss meter, and reflectometer.
Hunter Associates Laboratory, Inc. 6342

Glassware—A new catalog *Supplement SP-64* has been released. Featured in the 108-page book are such new items in the expanding Kimble line as a complete range of boiling and distilling flasks in Kimax "hard" glass.
Kimble Glass Co. 6343

Colorimeter—*Bulletin CM-1200* describes the new colormaster differential colorimeter for measurement of color. The new colormaster features an adjustable zero attachment for standardizing the instrument. Readings are given in terms of green, red, and blue reflectance values, or *X*, *Y* and *Z*.

(*Continued on p. 87*)

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for precise measurement of thermal expansion

Accurately measures coefficient of linear expansion of specimens up to ½" in diameter and from 2" to 3" long, at temperatures up to 1000° C. Dial gage readings to 0.0001".

Testing procedure described in "Standard Method of Test for Linear Expansion of Metals" (A.S.T.M. Designation: B95) and ". . . of Plastics" A.S.T.M. Designation: B696).

D1200 (above) consists of fused quartz dilatometer with precision dial gage, durably-constructed furnace, control panel with temperature and current indicators, rheostat.

Write for Bulletin 140-53

The Gaertner Scientific Corporation

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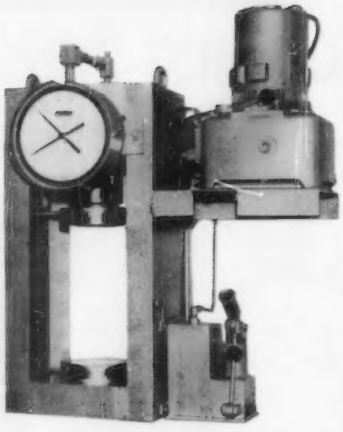
- 250,000 LB. LOAD RATING FOR CYLINDERS, CORES, BLOCKS, BEAMS, CUBES, BRICK AND DRAIN TILES



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SMS INSTRUMENT COMPANY
P. O. Box 24, Rensselaer, N. Y.

CIRCLE 862 ON READER SERVICE CARD

NEW LITERATURE

(*Continued from p. 85*)

Rapid computations to *L*, *a*, and *b* may be readily made with charts or the colormaster computer.
Manufacturers Engineering & Equipment Corp. 6344

Gamma Spectrometer—New 12-page *Brochure No. 704* describes an improved spectrometer system for identifying, tracing, and labeling gamma-emitting radioisotopes. Known as the GSS-1, the system employs a new analytical principle to obtain higher resolution. It can analyze emitters within the approximate energy range from soft X-rays to above 6 mev.
Nuclear Measurements Corp. 6345

Laboratory Catalog—Well-illustrated, 16-page catalog shows a number of new items recently introduced, as well as several specialties manufactured.
Palo Laboratory Supplies, Inc. 6346

Viscosity-Temperature Recorder—Two types of electronic strip-chart recorders especially designed for use with Scott Model NBS and Model STI Mooney shearing disc viscometers, testers for precise evaluation of elastomers in conformity with ASTM specifications, are described in a bulletin now being offered.
Scott Testers, Inc. 6347

Microstoning—The first complete information on all Taft-Peirce/Supfina microstoning equipment is now available in a newly published comprehensive catalog. *Catalog No. 319* explains the advantages of microstoning, the new process in which special abrading or polishing stones are oscillated against moving work pieces to generate controlled microinch finishes while correcting out of-roundness and removing surface imperfections left by prior machining.
Taft-Peirce Mfg. Co. 6348

Water Analysis—Two-page data sheet describing methodology for continuous, automatic analysis of water hardness with the AutoAnalyzer system is available.
Technicon Controls, Inc. 6349

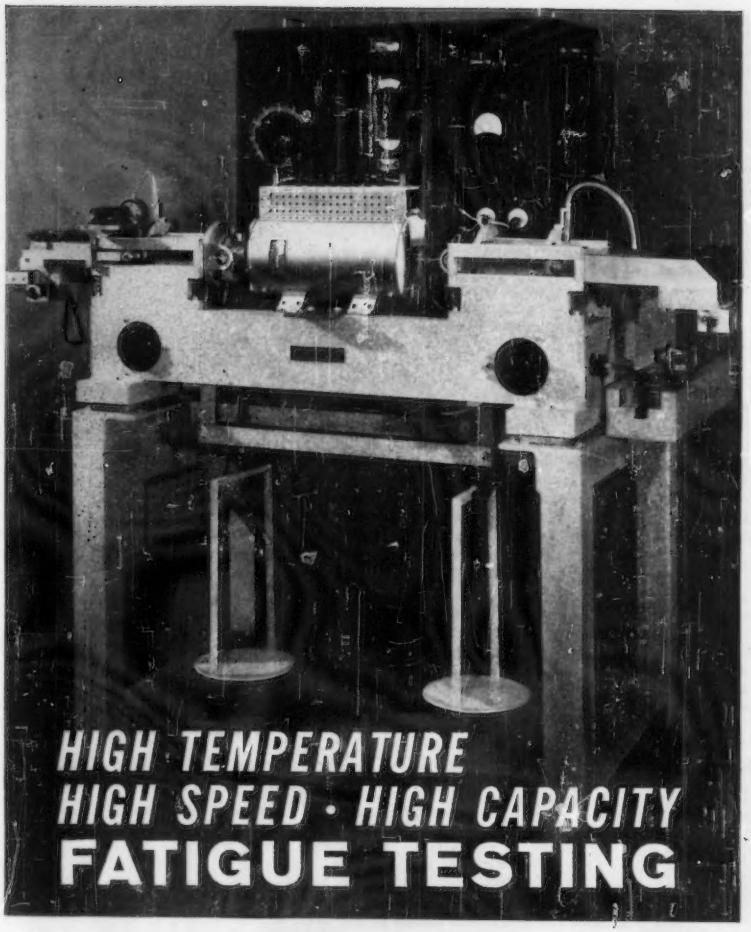
Catalog—*Testing U.S.A.*, a 4-page bulletin which comes out six times a year, is free for the asking to qualified personnel. This bulletin describes many new machines and test methods for all industries.
Testing Machines, Inc. 6350

Thermocouple Selector—A 4-page catalog on several new designs in compact multipoint thermocouple selector switches has been released. The catalog describes how these switches may be used for many temperature checking applications.
Thermo Electric Co., Inc. 6351

Testing Sieve—*Bulletin No. 608* covering 1960 revised specifications for testing sieves, embodied in the new ASTM specification E 11-60 T is now available. The bulletin also lists specifications being proposed as international standards. The new specifications combine the former coarse and fine series into a single series. Wire diameters are specified to produce a progressive relationship between sieve openings and wire diameters throughout the entire series.
The W. S. Tyler Co. 6352

Hardness Tester—In addition to containing information on the principle of the Rockwell hardness test and of microhardness testing, *Catalog RT-60* illustrates and describes Rockwell and superficial hardness testers, and Tukon microhardness testers in a man-

(*Continued on p. 88*)



with the new 850 in.-lb. Rotating Beam Machine from Budd

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For details, write or call for Bulletin BM-2050.

Other Budd testing equipment includes Tatnall creep testing machines and tensile testing machines, and Tatnall-Krouse variable speed plate machines, constant speed sheet machines, and other rotating beam machines. We will be glad to help you evaluate your testing requirements and select the right equipment.

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In Canada:
Budd Instruments, Ltd., 170 Donway West, Don Mills, Ont.

FOR FURTHER INFORMATION CIRCLE 863 ON READER SERVICE CARD

NEW LITERATURE

(*Continued from p. 87*)

ner that makes it easy to select the proper model for specific requirements.
Wilson Mechanical Instrument Div. 6353

FOR THE LABORATORY

Transducer—A new dew point transducer, Type No. 7600, has been developed to measure dew points in ranges from −20 to +60 F. The No. 7600 is particularly suited for outlet measurement of endothermic gas generators used in controlled-atmosphere heat treating.
Alnor Instrument Co. 3542

Tension Gage—A new spring tension gage used for measuring the "breakaway" force needed to move an object held by a spring member, inertia, or friction is available. The new gage features a uniformly graduated dial and knife-edged pointer which permit easy, accurate readings over the entire scale. It is a "push-pull" instrument with the zero reading at the top of the dial.
American Machine and Metals, Inc. 3543

Chromatography—Chromatograph users will be interested in a new solid support, recently developed. The support, a calcined diatomaceous earth material, is characterized by high flow rates without deterioration of other characteristics. Gas-Chrom is available in the regular and acid-washed grades and also in an acid-base washed grade.
Applied Science Laboratories, Inc. 3544

Relative Humidity and Dewpoint—A new line of "A + SHAW" relative humidity and dewpoint instruments is announced for measuring dewpoints as low as −150 C in a matter of seconds. Accurate readings are obtained regardless of flow rate. This instrumentation is suited for continuous readout or random sampling of atmospheres in such applications as dry gases, catalytic cracking, semiconductor manufacture, moisture in polymers, etc.
Atkins Technical, Inc. 3545

Fade-Ometer—A new line of Xenon arc fade-ometers and weather-ometers is announced. With a spectral energy distribution very close to that of natural sunlight, the Xenon lamp is ideal for use as the source of radiation in accelerated fading and weathering machines. The lamp employed in these new machines is a 6000-w water-cooled Xenon lamp which provides sufficient intensity to permit simultaneous exposure of a large number of samples of a generous size. The specimen rack of these machines has a diameter of 37¾ in. and will accommodate up to 54 specimens 3 by 9 in. in size.
Atlas Electric Devices Co. 3546

Strain Detector—A full-color, dual-purpose polariscope has been designed for both bench and portable use in detecting strains in glass and plastic. The Model P5 instrument is used in glass-working facilities, glass production plants, the electronics and optical industries, and related activities. It is useful for such purposes as detecting strains in ring seals and elsewhere in laboratory glassware, identifying strain patterns in tempered glass, inspecting glass-to-metal seals, examining strains in optical frames, and studying strain patterns in plastic scale models used by engineers and architects.
Bethlehem Apparatus Co., Inc. 3547

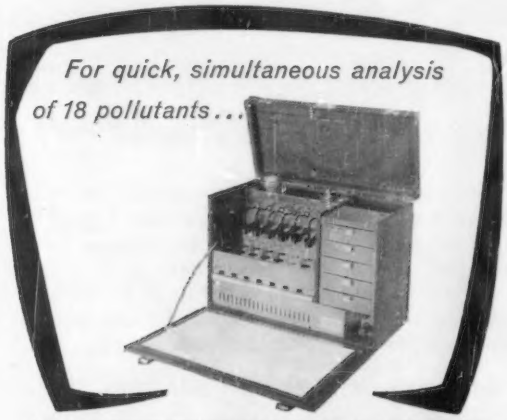
Thermocouple—A conditioner and calibrator to aid in accurately recording dynamic temperature variations has been introduced. For optimum accuracy while using multichannel recording oscillographs for dynamic temperatures, it is necessary to calibrate out errors due to the loss in the input cabling.
B & F Instruments, Inc. 3548

Rosette Gages—A new PhotoStress rosette gage has been put on the market which provides directly both orientation and separate magnitudes of principal strains. This important feature, coupled with speed and ease of application, promises to greatly simplify stress analysis problems.
The Budd Co. 3549

Belt Surfacer—The Surfmet belt surfacer features the following advantages: wet operation, compact design, large 4 by 9 in. grinding surface, fully guarded for operator's protection, simplified belt changing, and constant belt tension.
Buehler, Ltd. 3550

Gas Chromatography—Designed for the most accurate chromatographic analysis possible, this new instrument, Model K-7, uses ionization detection by thermionic emission —the only method that will analyze both organic and inorganic compounds as well as fixed or permanent gases.
Burrell Corp. 3551

Titrator—The olefin content of gasoline reported as its bromine number has become an important factor to petroleum marketers and refiners now that a direct correlation with smog and eye irritation has been found. The automatic olefin titrator will quickly measure the bromine number with excellent accuracy without the standardization of solutions or samples.
Central Scientific Co. 3552



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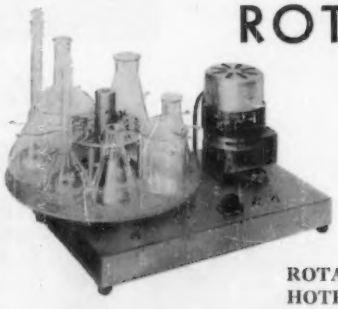
ROTO-TILT



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Eberbach new "Roto-Tilt" is essentially a rotating and tilting hotplate upon which glassware can be secured. It imparts a motion to the individual container very similar to that induced when the technician swirls the liquid manually. Amount of heat applied and speed of swirling action are variable. It is a continuous duty shaker with speeds of 0 to 200 r.p.m. Spring fingers hold beakers, flasks equidistant from the center providing uniform motion and agitation. Write for bulletin 60GF.

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P. O. Box 1024 Ann Arbor, Michigan

CIRCLE 865 ON READER SERVICE CARD

Environmental Unit—Custom-engineered environmental units for use with standard tension test equipment are being manufactured. Model Su-120-1-HCR is typical of these highly specialized test chambers which are custom-tailored to specifications. It has a temperature range from −120 to +300 F. The cabinet is self-contained, and the height of the chamber is hydraulically controlled for different levels of operation within the crossheads, without physical contact between the temperature chamber and the testing machine.
Cincinnati Sub Zero Products 3553

Moisture Measurements—After a year's field testing, a transistor instrument, called Raincheck, for measuring moisture in the ground has been developed. The unit consists of a probe and a reader. Probes in lengths up to 5 ft or more are inserted in an augered hole 1 in. in diameter.
Communications Control Corp. 3554

Pryometer—A new line of heavy-duty millivolt pyrometer controllers with solid-state control units has been introduced. The new pyrometer features a galvanometer sensing element, high-resistance input circuit, spring-backed jewel bearings for shock resistance, minimum full-scale span of 10 mv ±0.5 per cent accuracy against scale, and ±1 per cent accuracy within an ambient range of 50 to 120 F.
Daystrom, Inc. 3555

Strain Gage Indicator—Accurate indication or recording of static and dynamic strain gage measurements is achieved with the new Model 800 strain gage indicator. Designed for maximum versatility as a research tool, the instrument provides features and adjustments to accommodate all commonly used gage factors, gage resistances, and transducer bridge configurations.
Daytronic Corp. 3556

Corrosion Test—Now available is a new accelerated corrosion test for steel supplied as two separate solutions which when freshly mixed provides a readily reproducible corrosion test.
Eastern Sci. Mfg. Co. 3557

Pulse Generator—The first commercially available, all-electronic millimicrosecond pulse source capable of delivering a positive and negative pulse simultaneously has been developed. Pulse amplitudes are fixed at approximately 8 v into 50 ohms. Pulses may be varied from 2 to 100 millimicroseconds by means of an external charge cable, and outputs are preceded by a trigger pulse available on the front panel.
Edgerton, Germeshausen & Grier, Inc. 3558

Replica Kit—A new kit has been devised by the makers of the Talysurf to accurately reproduce surface finishes for inspection on a Talysurf or interferometer. Packaged in a compartmented case, the kit comprises 24 jars of powder with 24 glass ampules of mixing liquid. Accessories include a container of solvent, a block of plasticine, a steel file, and wooden mixing sticks.
Engis Equipment Co. 3559

Drain and Sewer Tile Tester—A 14,000-lb capacity precision tile testing machine, designated as Model PT-14, is designed specifically for testing clay and concrete drain and sewer tile up to 24-in. ID in lengths up to 48 in.
Forney's, Inc. 3560

Strain Gage Plotters—A new line of Model 114 strain gage plotters has been announced. The Model 114 is a multichannel recording and plotting instrument for strain gage use, available with 48 or 96 channels. It requires no manual plotting or reading, automatically records data in visual form for "on-the-spot" evaluations. Other features include 3 zero positions per channel, individual graphs for each channel, individual channel lights and a portable motor-driven zero balance gun.
Gilmore Industries, Inc. 3561

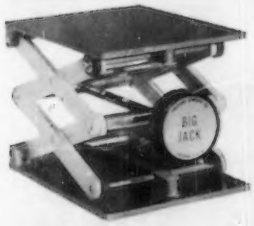
Flaw Detector—To ferret out defects and ensure precision and uniformity in parts manufacturing missile guidance components, and other critical assemblies, engineers can now rely on permanent three-dimensional photomicrographs produced by a 35-mm stereo graphic camera. Affixed to a cyclotic stereoscopic microscope, the Graflex camera is part of a complete, easy-to-operate inspection system, which also includes a stereo viewer and a mounting bracket for the correcting prism.
Graflex, Inc. 3562

Ultrasonic Generator—A compact and highly flexible 100-w ultrasonic generator suited to a wide variety of ultrasonic applications is available. The Inson 100 PW generator has connections for any of 10 output impedances, which may be selected from a broad range to match any impedance requirement.
International Ultrasonics, Inc. 3563

Oxygen Analyzer—Measures the concentration of dissolved oxygen in a variety of fluid systems including sewage, biological, natural and fresh sea water, and some organic media. Based on current produced by the reduction of oxygen at a platinum electrode, the instrument is compact and portable.
Jarrell-Ash Co. 3564

(*Continued on p. 90*)

BIG JACK for effortless, vertical LIFTING...3 to 12 inches COMPLETELY STABLE AT FULL OPENING



Base and platform cast aluminum . . . finished in dark gray. Four mounting holes in base for attaching to table top and tapped hole in loading platform for adding a ½" threaded support rod when either are desired.

Now you can lift heavy flasks, hot plates, baths, heaters and ground joint glassware easily and safely. A most useful laboratory item especially when working with complex setups. Handy, no trouble . . . scissors type lifting action always sure. Large knob with serrated edges for raising or lowering objects up to 100 lbs. Uses a screw type drive . . . steady operation at all times.

LITTLE JACK... a smaller model of Big Jack designed for work with small objects. Will lift or lower up to 10 lbs. 1½" to 5" lifting height . . . ideal for micro work.

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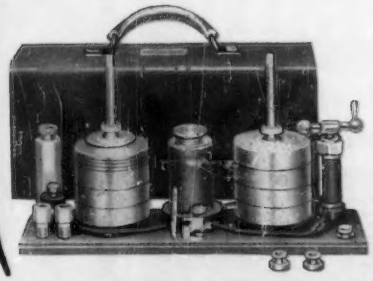
CIRCLE 866 ON READER SERVICE CARD

For precise measurement of pressures . . .



DEAD WEIGHT GAUGE

Portable instrument conveniently measures line pressures, rock pressures at wells, static pressure on orifice meters, and gas pressure on pipe line leakage tests. Maximum pressure: 500, 1000 and 1500 psi. Graduations: 1 or 1/10 psi. Write for information. No. 35250-1 $140.00 (*Prices to* $237.50)

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CIRCLE 867 ON READER SERVICE CARD

FOR THE LABORATORY

(*Continued from p. 89*)

Roughometer—The roughometer SR-14 is a portable instrument for the measurement of surface roughness of metal or plastic parts. It is contained in a plastic case 6¼ by 3¼ by 3¼ in. that has a storage compartment for the pickup and calibration standard. Automatic reel rewind is provided for the pickup cable.
Marduth Products. 3565

Magnetic Control Board—Visual controls with instantly changeable magnetic devices—visible for all to see and be guided by—are saving time and increasing efficiency for various control administrators.
Methods Research Corp. 3566

Strain Gages—Developed is an integral-lead strain gage which features fast installation, high (750 F) temperature stability, reliability, and adverse environmental use. A stainless steel tube is fused into SS-E-5 or SS-E-6 weldable strain gages. Lead wires are attached and brought out through the tube. The result is a gage and lead wire assembly which is hermetically sealed and can be immersed even in corrosive media.
Micro-Test, Inc. 3567

Proving Ring—A device which vibrates a proving ring reed automatically has been introduced. It is a self-powered unit designed for easy attachment to standard Morehouse proving rings already in the field, or it can be supplied optionally on new proving rings. The vibrator's action dampens out very easily upon contact thereby increasing the ultimate accuracy of the proving ring through heightened sensitivity.
Morehouse Machine Co. 3568

McLeod Gage—A McLeod-type gage which requires no batteries or electrical connections and needs less than 8 oz of mercury is announced. This gage, named the Measuvac TD-1, is unique in many respects and may be used as a portable instrument or operated from a fixed mount.
The New York Air Brake Co.
Kinney Manufacturing Div. 3569

Sheet Metal Tester—A versatile sheet metal testing machine that simulates actual deep-drawing press operations has been announced. With the new Ductomatic sheet metal tester, the ductility or forming quality of sheet metal can be predicted with an exceptionally high degree of accuracy.
Tinius Olsen Testing Machine Co. 3570

Oil Tester—A new system for testing the durability of lubricating oils for wick-fed journal bearings is said to be simpler and give more precise results than existing methods. The Pemoot will enable bearing designers and lubrication engineers to test up to six samples of oil simultaneously under laboratory conditions which are virtually indistinguishable from those encountered in actual bearing applications.
Permawick Co. 3571

Magnetic Particle Inspection—The Ferroflux and Portaflux portable magnetic particle testers are light enough for one man to carry on the job to solve a variety of inspection problems. They approach the capabilities of larger machines, and each is contained in a compact carrying case. The new Picker equipment is said to detect surface and near-surface flaws on a wide variety of metal products either in the field or in the plant.
Picker X-Ray Corp. 3572

Hot Plate—A new line of hot plates encompassing four types and a total of eleven models is announced. Among the many new features are fully adjustable, stepless temperature control, modern styling, and unique design which keeps heat on top while the sides and bottom stay cool.
Precision Scientific Co. 3573

Spectrum Programmer—Much routine labor normally associated with material fatigue testing is eliminated by this unique automatic test load spectrum programmer. Instead of repeatedly resetting his load cycling equipment for each band of the load spectrum as in a normal fatigue test procedure, the engineer using this programmer merely charts (on separate sheets of graph paper) the amplitude and frequency of load cycles for one complete spectrum. He then attaches these program charts to two rotating drums in the instrument, sets a "count-down" type counter at the total number of cycles or the total number of spectrum repetitions desired, and presses a starting switch.
Research, Inc. 3574

Chromatography—Portability, economy of space, and solvent resistance are characteristics of the Chromatobox, a new chromatography developing chamber. Chromatograms 2 in. wide by 17 in. long are developed in the Chromatobox, yet its over-all dimensions are only 3 by 3 by 2 in. All parts are made of solvent-resistant plastic or glass.
Research Specialties Co. 3575

Joint-Bond Test—A new joint extension machine for testing the strength of bonds formed by concrete pavement joint sealers is now available. The design and operation of the joint-bond apparatus is in accordance with federal specifications, Corps of En-

(*Continued on p. 92*)

DILLON *Universal* TESTER

Motorized or Hand Operated

Engineering skill at its highest! COMPRESSION-TENSILE-TRANSVERSE and SHEAR testing combined in *one* portable instrument.

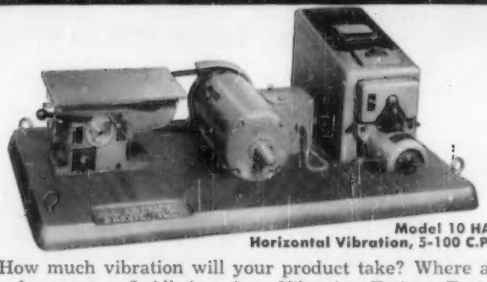
7 different gauges available—all interchangeable! Capacities from 250 up to 10,000 lbs. Dillon Universal Tester handles rounds, flats or special shapes and—for split accuracy—is calibrated with Proving Ring certified by U. S. Bureau of Standards. Has maximum hand, self-aligning grips, ball bearings. America's most popular low-priced tester! Write for illustrated brochure.

W. C. DILLON & CO., INC.
14610 Keswick St.
Van Nuys 24, Calif.

Conforms to most ASTM, Federal and Military Specifications L-21

CIRCLE 868 ON READER SERVICE CARD

ALL AMERICAN TESTERS
SPOT VIBRATION WEAK SPOTS BEFORE COSTLY FAILURE!



Model 10 HA-T
Horizontal Vibration, 5-100 C.P.S.

• How much vibration will your product take? Where are the danger areas? All American Vibration Fatigue Testers answer these questions in your shop or laboratory with shake-down tests that simulate field service vibrations. Engineering gets the facts needed to improve design at lowest cost. Equally effective in spot-checking production runs.

• All American Testers meet U.S. Government specifications for horizontal or vertical vibration testing of all sizes and shapes of units weighing up to 150 lbs. Range Selector automatically controls acceleration and deceleration, or holds vibration frequency at any desired point between 5 and 100 cycles per second.

CATALOG "F"
gives full facts on all 10 All American Testers, proved in long service to government and industry.
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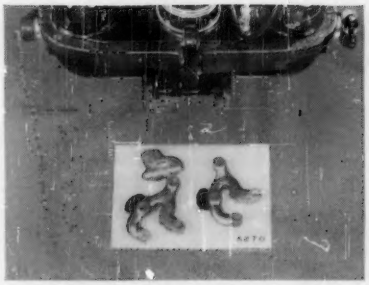
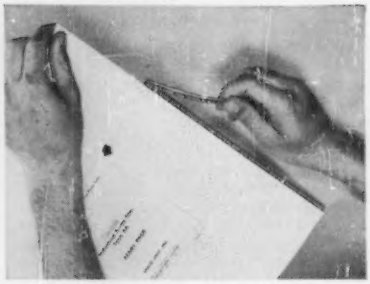
CIRCLE 869 ON READER SERVICE CARD

1) No darkroom loading. Ready for exposure as it comes from the box.



2) Just place in position and expose —the film is protected from dust, dirt, light and moisture.



3) In the darkroom, pull the rip strip, remove film, and process.

...NEW!... READY PACK ....

Kodak Industrial X-ray Film

- Sealed tight until processed—keeps clean
- Very convenient to handle—saves time
- Readily available in Type AA and Type M

Here's new convenience when you are inspecting aluminum or magnesium alloys, thin steels, plastic or anything where lead screens are not required.

Kodak Industrial X-ray Film, Type AA and Type M-Ready Pack comes to you with each sheet sealed in a light-tight envelope ready for exposure. A convenient rip strip makes it easy to open in the darkroom.

These films come 75 to a box in sizes 8 x 10, 10 x 12, 11 x 14, 14 x 17. Order them from your Kodak X-ray dealer.

EASTMAN KODAK COMPANY
X-ray Division • Rochester 4, N. Y.

Kodak
TRADE MARK

FOR FURTHER INFORMATION CIRCLE 870 ON READER SERVICE CARD

FOR THE LABORATORY

(*Continued from p. 90*)

gineers requirements, and with the procedure of ASTM Method D 1191.
Soiltest, Inc. 3576

Tester for Concrete—Transverse testing machines for determining the flexural strength of concrete specimens are now available. Designated Model TF-179, the bench-mounted testers have a capacity of 2000 lb. They apply a uniform load at a pre-set rate, which can be varied to suit different requirements. For flexural tests conforming to the ASTM standard, which specifies specimens 40 mm square by 160 mm long, the load rate is set at 600 lb per min.
Steel City Testing Machines, Inc. 3577

Tensile Tester—The TMI tensile tester is now available with an autographic recorder which incorporates the latest design features of a simple mechanical recording device for tensile strength and elongation. The basic tension tester uses a dead-weight pendulum with a choice of several strength ranges.
Testing Machines, Inc. 3578

Laboratory Balance—High capacity (up to 6 kg), high sensitivity (0.1 g), and a sturdy all-aluminum case are the features of a new line of multi-purpose laboratory balances. Two models are offered: 195-B has a sensitivity of 0.1 g; capacity of 3 kg (7 lb); tare capacity of $\frac{3}{4}$ lb; beam graduated to 100 g, 50 g, or 8 oz. Model 2-89B has capacity of 6 kg with beam graduated to 500 g, 100 g, or 16 oz.
Henry Troemner, Inc. 3579

Thickness Tester—A new instrument for gaging the thicknesses of coatings on iron and steel has been introduced. Identified as the Type ES Permascope, the device provides a nondestructive means of measuring thicknesses of organic and nonmagnetic metal coatings (including phosphate) with the accuracy of the microscopic method.
Twin City Testing Corp. 3580

Environmental Chamber—A new environmental chamber to simulate space conditions up to 500,000 ft is announced. Known as Model WF-27-125 + 350, it has an adjustable temperature range from −125 to +350 F. Pull-down over the entire range requires 90 min, while heat-up takes 60 min.
Webber Manufacturing Co., Inc. 3581

Ultrasonic Cleaning—Available for immediate delivery is a budget-priced, single-unit ultrasonic cleaner SG-2 designed especially for the hundreds of routine cleaning chores encountered daily in most laboratories.
Will Corp. 3582

Thermometer—This new battery-powered, remote-reading, continuous-indication, thermistor thermometer covers a range of −40 to +150 C (42SC) and −40 to +300 F (42SF) in two models each having three overlapping ranges. The Model 42 utilizes a transistor-controlled, constant-current wheatstone bridge to allow monitoring of a wide range to an absolute accuracy of ±0.5 C or ±1 F in conjunction with thermistor probes.
Yellow Springs Instrument Co., Inc. 3583

INSTRUMENT COMPANIES

Giannini Scientific Corp., New York, N. Y.—Has just completed its third acquisition this year, the latest company acquired being Micro-Balancing, Inc., Garden City Park, L. I., N. Y., Dr. Gabriel M. Giannini, president, announced. Micro-Balancing, Inc., presently manufactures a line of dynamic balancing machines and photocell control devices for street, yard, and home lights.

MATERIALS

Alloy Steel—A new 16-page booklet entitled *Allegheny Ludlum Moly Permalloy* is now being distributed. This technical discussion gives detailed background on this special alloy for use in the electronic industry. Included in the booklet is information on testing data, hysteresis loops, special heat-treating data, magnetization curves, core loss graphs, typical physical, mechanical and magnetic properties, as well as other special data.
Allegheny Ludlum Steel Corp., Pittsburgh, Pa.

Tubular Steel—A new 6-page folder, *T-467*, contains information on 15 steels widely used in high-temperature service. Included is a chart containing data on tensile properties, thermal conductivity and expansion, creep strength, oxidation resistance and other such mechanical and physical properties of importance to application engineers.
The Babcock & Wilcox Co., Beaver Falls, Pa.

Commercial Glasses—A booklet B-83 which details properties of 32 commercial glasses has been published by Corning Glass Works for engineers, designers, and other technical personnel. The 16-page booklet is a revised edition of the company's publication *Properties of Selected Commercial Glasses*. It contains information on several new glasses as well as new sections on thermal expansion and optical properties.
Corning Glass Works, Corning, N. Y.

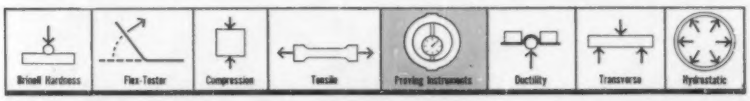
Lubricant—Surf-Kote L-1020 is a new lubricant for high-temperature, high-pressure applications. It contains a modified molybdenum disulfide compound and other additives suspended in a synthetic base vehicle. The vehicle evaporates and leaves a durable dry film of solid lubricating compound on most metal surfaces, preventing galling, seizing, fretting corrosion, cold welding, and similar friction problems. The non-inflammable lubricant is specifically formulated for use under high-pressure, high-temperature conditions up to 750 F.
Hohman Plating & Mfg., Inc., Dayton 4, Ohio

Epoxy Adhesive—Maraset resin 533A, a two-component, contact-pressure epoxy adhesive that can be cured at room temperature to provide high bond strength, has been developed. The resin is furnished as a solvent-free, non-volatile, medium-thick paste with a two-hour pot life. It meets MIL-A-8623, Type II, the federal specification for the aircraft industry.
Marblette Corp., Long Island City, N. Y.

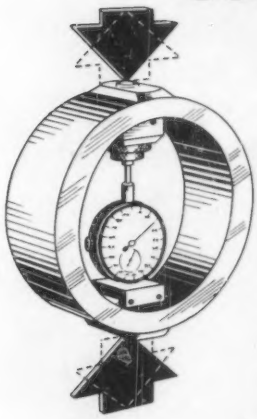
Spring Wire—A vacuum-melted, nickel-base alloy wire designated Rene' 41 has been introduced by the National-Standard Company for springs to be operated at temperatures to 1800 F (approximately the melting point of copper). Rene' 41 is made on a base of nickel with chromium (18 to 20 per cent), cobalt (10 to 12 per cent), molybdenum (9.00 to 10.50 per cent), iron (5.00 per cent max), titanium (3.00 to 3.30 per cent), aluminum (1.50 to 1.80 per cent), and carbon (0.06 to 0.12 per cent).
National-Standard Co., Niles, Mich.

Glass Fiber—A glass fiber possessing approximately 50 per cent greater rigidity with

(*Continued on next page*)



proving rings to measure any load
COMPRESSION or TENSION



Steel City offers two styles of proving rings which require no adjustment during use. The dial-indicator ring (illustrated) measures deflection in increments of 0.0001". Applied load or force is determined from a calibration report furnished with each instrument*. With this type of ring, even an inexperienced operator can repeat readings as close as 1/10 of 1%.

Optical-type proving rings, developed for the USAF, use a ruled scale and a high-powered microscope for readings in increments of 0.00002". Repeat readings as close as 1/20 of 1% can be achieved.

Compression and tension models are available in either style, with capacities up to 200,000 lb., all manufactured of special-alloy steel by experienced craftsmen. They are used for calibrating Brinell testers, testing machines and presses, and load cells, or for measuring applied loads.

* *National Bureau of Standards calibration report when desired.*

Write for literature, prices and name of nearest distributor.

Steel City Testing Machines Inc.
8805 Lyndon Ave., Detroit 38, Mich.

FOR FURTHER INFORMATION CIRCLE 871 ON READER SERVICE CARD

MATERIALS

(*Continued from preceding page*)

no sacrifice in strength has been developed. Known as "high modulus glass," the new fiber will permit important weight savings in the development of aerospace vehicles and missiles through its use as a reinforcement in structural plastic laminates.

Owens-Corning Fiberglas Corp., New York, N. Y.

Asbestos-Silicone Paper—A unique type of base paper with superior qualities of heat, water, and corrosion resistance has been announced. The base paper, saturated with silicone, is one of a series of Novabestos products, such as treated papers, composite paper, and glass cloth materials.

Raybestos-Manhattan, Inc., Manheim, Pa.

Alloy Iron Properties—The Centrifugally Cast Products Div. of The Shenango Furnace Co., Dover, Ohio, has announced a new *Bulletin No. 158* charting the engineering properties of meehanite metal, ni-resist iron, ni-resist ductile iron, and ductile iron. Included in this valuable reference summary are the mechanical properties, physical properties, and chemical composition covering a wide range of Shenango centrifugally cast irons.

The Shenango Furnace Co., Dover, Ohio

Titanium Alloy—A new creep-resistant titanium alloy, extending titanium's useable strengths in jet engines to 900 F, has been introduced to the commercial market. Through it, titanium metal has thus broached the 650 F temperature barrier it has traditionally faced in jet engine construction. The metal has long been used for unstressed airframe parts at temperatures nearing 1000 F. The new TMCA alloy, designated Ti-8Al-1Mo-1V, contains 8 per cent aluminum and 1 per cent each of molybdenum and vanadium, in addition to 90 per cent titanium.

Titanium Metals Corporation of America, New York, N. Y.

OTS Research Reports

THESE REPORTS, recently made available to the public, can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Order by number.

A Relaxation Time Technique for Measurement of Thermal Diffusivity, PB 161752, 75 cents.

Investigation of Far Infrared Spectra, PB 161738, $1.

A New Instrument for the Determination of Molecular Weight by Differential Vapor Pressure, PB 161711, 50 cents.

Fundamentals of Ultrasonic Welding (Phase 1), PB 161677, $2.50.

Research and Development Leading to the Establishment of Ultrasonic Test Standards for Aircraft Materials, Feb., 1960, PB 161753, $2.75.

Research and Development Leading to the Establishment of Ultrasonic Test Standards for Aircraft Materials, Oct., 1957, $3.50.

Ultrasonic Determination of Elastic Constants at Room and Low Temperatures, PB 161514, 50 cents.

Corrosion Control of Copper and Steel by Vacuum Deaeration, GAT-296, 50 cents.

A Versatile Autoclave Facility for Aqueous Corrosion Research, HW-64111, 75 cents.

Aqueous Corrosion of Magnesium Alloys, ANL 6070, 50 cents.

Metallography of Aluminum and Some Aluminum-1 Per Cent Nickel Alloys, ANL-6144, 50 cents.

Characteristics of Anodic and Corrosion Films on Zirconium, ANL 6149, 50 cents.

Preparation of Magnesium Oxide Refractories, ANL 6164, 50 cents.

Factors Affecting the Ductility of Iron-Chromium-Aluminum Alloy Sheet, BMI-1450, 75 cents.

High Energy Storage Ceramic Capacitor, Final Report, NYO-9067, $2.25.

Research on Piezoelectric Materials and Phenomena, SC-4443(RR), $3.

Electron Mirror Microscopy in Magnetic and Metallurgical Studies, PB 161710, $2.25.

Crack Depth Leakage Flux Characteristics in Ferromagnetic Materials, PB, 161513, $1.25.

Research in Radiation Damage in Semiconductors, PB 161673, $3.

High Temperature Semiconductor Devices, PB 161541, $2.75.

A Practical Interpretation of Dielectric Measurements up to 100-Mc, PB 161545, $3.50.

Development of Partially Volatile Brazing Filler Alloys for High-Temperature Application and Resistance to Oxidation, PB 161746, $1.25.

No. 1470 AB HANDIMET GRINDER, complete $98.00

No. 1469-SW AB HANDIMET GRINDING PAPER for 1470 Grinder, Grits 240, 320, 400, 600 per 100....$10.00

No. 1469-1-SW AB HANDIMET GRINDING PAPER assorted 10 each grits 240, 320, 400, 600....$4.50

1470 AB

HANDIMET GRINDER

A New Wet Hand Grinder for Metallurgical Samples

Now you may have wet grinding facilities for hand preparation in your laboratory at a nominal cost. Convenience at your fingertips, always clean and ready for use. Simply attach to water and drain facilities.

Individual elevated hard glass grinding surfaces are continually flushed with streams of water. This floats off the surface removal products, provides lubrication, and leaves sharp abrasive edges exposed at all times. A control valve permits complete selectivity of the volume of water. Ample drainage facilities with standard pipe fittings are provided at the rear. The grinding platforms are pitched downward and away from the operator.

The Handimet Grinding Paper is coated with a pressure sensitive adhesive backing and firmly holds when merely pressed against the flat grinding surface. It is easily removable when sheet is worn.

Buehler Ltd. METALLURGICAL APPARATUS

2120 Greenwood St., Evanston, Illinois, U.S.A.

FOR FURTHER INFORMATION CIRCLE 872 ON READER SERVICE CARD

Federal Government Standards Index Changes

THE FEDERAL Supply Service of the General Services Administration is charged with the responsibility for establishing specifications to be used by the Federal Government for Procurement of materials and supplies. The GSA issues an annual Index of Initiation of Federal Specifications Projects, and monthly supplements.

The items listed below appeared in Supplements 6 and 7 for August and September, 1960.

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Class	Assigned Agency & Preparing Activity
(Supplement 6, August, 1960)				
Lubricants, Liquid Fuels and Related Products; Method of Testing	Chg. Not. 5	Fed. Std No. 791	..	DOD-Army-Ord
Metals Test Method	Rev.	Fed. Std. No. 151a	..	DOD-Army-Ord
Aluminum Alloy Permanent and Semi Permanent Mold Casting	New	QQ-A-596b	9500	DOD-USAF
Bars; Chisel Pinch, Pry, Wrecking Digging, Tamping, Digging and Tamping; and Crowbar	Am. 1	GGG-B-00101c	5120	GSA-FSS
Bolt (Square Neck, Machine, Ribbed Neck, Finned Neck, Tee Head, Key Head) (Round Head)	Rev.	FF-B-584b	5306	DOD-Army-Ord
Coating Compound, Rust Inhibitive, Fish Oil Base	New	TT-C-530a TT-C-00530	8630	DOD-Navy-Ships
Dishwashing Compound, Machine	Rev.	P-D-425a	7930	DOD-Navy-Ships
Enamel, Alkyd, Semi-Gloss	Am. 1	TT-E-529a	8010	DOD-Army-Ord
Enamel, Odorless, Alkyd, Interior Semi-Gloss White and Tints	Am. 1	TT-E-508a	8010	GSA-FSS
Floor Covering, Vinyl Wearing Surface, Felt Back	New	L-F-475	..	DOD-Army-CE
Gaskets, Rubber, Molded or Extruded (For Concrete Nonpressure Sewer Pipe)	New	HH-G-00160	..	DOD-Army-CE
Gasoline, Unleaded	Rev.	VV-G-109a	9130	DOD-Army-Ord
Glass Containers, One-Gallon Capacity and Smaller, For Other Than Medicinal Products for Domestic Shipment, Packaging and Packing of	New	PPP-G-460	8125	DOD-Army-QMC
(Supplement 7, September 1960)				
Pigments-In-Oil, Tinting Colors	Rev.	Fed. Std. No. 88a	..	DOD-Navy-Ships
Steel, Chemical Composition and Hardenability	Chg. Not. 1	Fed. Std. No. 66b	..	DOD-AFSSC
Tape, Paper, Computing Machine	New	Fed. Std. No. 9d	..	GSA-FSS
Aluminum Alloy Bars, Rods and Wire, Rolled Drawn or Cold Finish	Rev.	QQ-A-351	5925 9530	DOD-Navy-Weps
Aluminum Alloy Plates and Sheets, Alclad 2014 (R301, Clad 14S)	Rev.	QQ-A-255a	9535	DOD-Navy-Weps
Bulb, Dropping Pipet	New	RR-B-810	6640	DOD-Army-CmlC
Buret, Straight, Precision	New	DD-B-793	6640	DOD-Army-CmlC
Burners, Bunsen, Laboratory	Rev.	GG-B-817b GG-B-00817a	6640	GSA-FSS
Carpet, Loop, and Rug, Loop, (Wool Pile Knitted)	Int. Am. 1	DDD-C-80a	7220	GSA-FSS
Cement, Natural (for use as a Blend with Portland Cement)	Rev.	SS-C-18Ea	5610	GSA-FSS
Cement, Portland-Pozzolan	Rev.	SS-C-208c	5610	GSA-FSS
Cement, Slag	Rev.	SS-C-218a	5610	GSA-FSS
Clamp, for Ground Joint, Laboratory Glassware	New	RR-C-400	6640	DOD-Army-CmlC
Clamps and Clamp-Holders, Laboratory	Rev.	GG-C-411a	6640	DOD-Army-CmlC
Compound, Grease Cleaning Solvent Emulsion Type	Rev.	P-C-576a	6850	DOD-Navy-Weps
Conduit and Fittings, Asbestos-Cement or Fireclay-Cement (for Electrical Purposes)	Rev.	W-C-571b	5975	GSA-FSS
Crucible, Ignition, Laboratory	Rev.	GG-C-695b	6640	DOD-Army-CmlC
Cylinder, Graduated, Laboratory, Glass	New	DD-C-940	6640	DOD-Army-CmlC
Dish, Gum Test	New	DD-D-425	6640	DOD-Army-CmlC
Dish, Moisture Determination	New	GG-D-410	6640	DOD-Army-CmlC
Dishwashing Compound, Hand, (Neutral Synthetic Detergent, Solid Form)	Am. 1	P-D-410	7930	DOD-Army-QMC
Distilling Apparatus, Laboratory, with Graham Condenser	Rev.	GG-D-461d	6640	DOD-Army-CmlC
Dust Mop Treating Compound	New	P-D-800 P-D-00800	6850	GSA-FSS
Extraction Assembly	Rev.	GG-E-915b	6640	DOD-Army-CmlC
Flask, Dewar	New	DD-F-245	6640	DOD-Army-CmlC
Flask, Laboratory	Rev.	DD-F-250a	6640	DOD-Army-CmlC
Flask, Volumetric	New	DD-F-275	6640	DOD-Army-CmlC
Frame, Laboratory Apparatus Support	New	RR-F-600	6640	DOD-Army-CmlC
Funnel, Separatory	Rev.	DD-F-825a	6640	DOD-Army-CmlC
Graduate, Liquid, Laboratory	Rev.	DD-G-670	6640	DOD-Army-CmlC
Graduate, Liquid, Laboratory, Plastic	New	L-G-650	6640	DOD-Army-CmlC
Grid, Wire Gauze, Laboratory	Rev.	RR-G-675a	6640	DOD-Army-CmlC
Kerosine Water White Deodorized	Am. 1	VV-K-220	6810	DOD-Navy-Ships
Lubricating Oil, General Purpose Preservative (Water Displacing Low Temp.)	New	VV-L-800	9150	DOD-Navy-Weps
Mortar and Pestle	Rev.	GG-M-621c	6640	DOD-Army-CmlC
Pipe, Sewer and Drain, Plastic	New	WW-P-00380	5630	GSA-FSS

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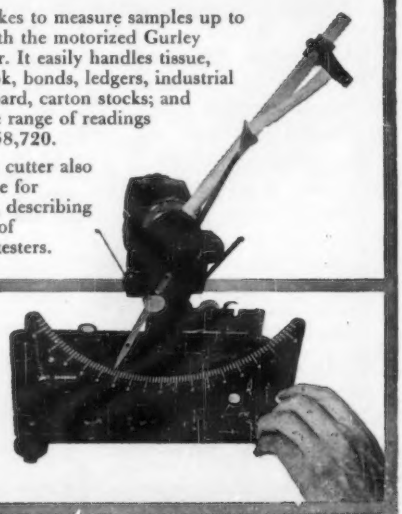

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PROMULGATIONS

Title	Type of Action	Symbol or Number
(Supplement 6, August, 1960)		
Aluminum Alloy Bars, Rods, Wire and Special Shapes; Rolled, Drawn, or Cold Finished, 2014, (Superseding QQ-A-266)..	Rev.	QQ-A-266a
Aluminum Alloy Bars, Rods, and Shapes, Extruded, 2024, (Superseding QQ-A-267).....	Rev.	QQ-A-267a
Aluminum Alloy Bars, Rods, and Wire, Rolled, Drawn or Cold Finished, 2024, (Superseding QQ-A-268).....	Rev.	QQ-A-268a
Aluminum Alloy Bars, Rods, and Shapes, Extruded, 7075 (Superseding QQ-A-277).....	Rev.	QQ-A-277a
Aluminum Alloy Bars, Rods, Wire and Special Shapes; Rolled, Drawn, or Cold Finished, 7075, (Superseding QQ-A-282)..	Rev.	QQ-A-282a
Aluminum Alloy Bars, Rods, and Wire; Rolled, Drawn, or Cold Finished, 5052, (Superseding QQ-A-315a).....	Rev.	QQ-A-315b
Aluminum Alloy Bars, Rods, and Shapes, Extruded, 2014, (Superseding QQ-A-261).....	Rev.	QQ-A-261a
Aluminum Alloy Bars, Rods, Wire, and Special Shapes; Rolled, Drawn, or Cold Finished, 6061, (Superseding QQ-A-325a).	Rev.	QQ-A-325b
Aluminum Alloy Bars, Rods, and Wire; Rolled, Drawn, or Cold Finished, 1100 (Superseding QQ-A-411c).....	Rev.	QQ-A-411d
Cement, Portland, (Superseding SS-C-00192c (COM-NBS) & & SS-C-192b).....	Rev.	SS-C-192d
Cord, Cotton, General Purposes, Sash and Venetian Blind...	Am. 4	T-C-571b
Pigment, Zinc-Yellow (Zinc Chromate), Dry.....	Am. 1	TT-P-465
Triphenyl Phosphate (For Use In Organic Coatings) (Superseding TT-T-00662a(GSA-FSS) & TT-T-662).....	Rev.	TT-T-662b
(Supplement 7, September, 1960)		
Lubricants, Liquid Fuels, and Related Products, Methods of Testing.....	Am. 5	Fed. Test Method Std. 791
Paper, Toilet Tissue.....	Rev.	Fed. Std. 6b
Pigments-In-Oil, Tinting Colors.....	Rev.	Fed. Std. 58a
Tape, Paper, Computing-Machine.....	Rev.	Fed. Std. 9d
Aluminum Alloy Rod and Wire, for Rivets and Cold Heading.	New	QQ-A-430
Antiseize Compound, White Lead Base, General Purpose (for Threaded Fittings) (Superseding TT-A-00580(GSA-FSS)).	New	TT-A-580a
Bottle, Narrow and Wide Mouth, with Ground Glass Stoppers (Superseding DD-B-593).....	Rev.	DD-B-593a
Cloth, Cotton, Flannel, (Heavy, for Table Felts) (Superseding CCC-F-456a).....	New	CCC-C-460
Detergent, Surgical.....	New	P-D-240
Dishwashing Compound, Hand (Neutral Synthetic Detergent, Solid Form).....	Am. 1	P-D-410
Drums, Metal, 55-gal (for Shipment of Noncorrosive Material).....	Am. 1	PPP-D-729b
Felt Sheet (Hair) and Felt Roll (Hair) (Superseding C-F-202).	Rev.	C-F-202a
Light, Color Perception Testing.....	New	GG-L-340
Molding Plastic, Cellulose Acetate.....	Am. 2	L-M-505
Molding Plastic, Polystyrene.....	Am. 3	L-M-520
Molding Plastic, Polystyrene, Modified.....	Am. 4	L-M-525
Molding Plastic, Polyvinyl Chloride, Rigid.....	Am. 3	L-M-530a
Sacks, Shipping, Paper, (Cushioned) (Superseding PPP-B-0030a(GSA-FSS) & PPP-B-30).....	New	PPP-S-30
Screening, Nonmetallic, Insect, (Polyvinylidene Chloride) (Superseding L-S-139).....	Rev.	L-S-139a
Soap, Laundry, Chip.....	Am. 1	P-S-580a
Soap, Surgical, Cake and Liquid.....	New	P-S-615

INTERIM FEDERAL SPECIFICATIONS ISSUED

Title	Type of Action	Symbol or Number
(Supplement 6, August, 1960)		
Lacquer, Nitrocellulose and Acrylic, Aerosol (In Pressurized Dispensers).....	Rev.	TT-L-0050a
Paint, Black, Ready-Mixed.....	New	TT-P-0061c
Paint, Exterior, Chrome-Green, Ready-Mixed.....	New	TT-P-0071c
Paper, Newsprint.....	New	UU-P-00405
Pigment, Cadmium Red (Cadium Lithopone); Dry.....	New	TT-P-00341
Pigment, Chrome-Yellow and Chrome-Orange; Dry.....	Rev.	TT-P-00346a
Pigment, Ocher; Yellow, Dry.....	New	TT-P-00420
Pigment, Yellow-Iron-Oxide; Hydrated, Synthetic, Dry.....	New	TT-P-00458
Pigment, Zinc Oxide, Leaded (Dry and Paste-In-Oil).....	New	TT-P-00462
Pipe, Steel (Seamless and Welded, Black and Zinc-Coated (Galvanized).....	Am. 2	WW-P-00404b
Plywood, Container Grade.....	Am. 1	NN-P-515a
Primer Coating, Latex Base, Interior, White (For Gypsum Wallboard).....	New	TT-P-00650
Sealer, Sanding, Lacquer Type (For Wood Furniture).....	New	TT-S-00100a
Synthetic Filaments, General Specification for Brushes.....	Am. 1	H-S-951a
White Lead, Basic-Carbonate, Dry, Paste-In-Oil and Semipaste Containing Volatile Thinner.....	Rev.	TT-W-00251d
Zinc; Slab (Spelter).....	Am. 2	QQ-Z-351a
(Supplement 7, September, 1960)		
Borers, Cork (GSA-FSS) (Rev. FS).....	New	GG-B-00591a
Burners, Bunsen, Laboratory (GSA-FS)(Rev. FS).....	New	GG-B-00817a
Cleaning Compound, Solvent, Grease Emulsifying (Navy-Wep)..	Rev.	P-C-00576b
Cloth, Thread, and Tape-Asbestos (Navy-Ships).....	Am. 1	SS-C-00466b
Coating Compound, Rust Inhibitive, Fish Oil Base (Navy-Ships).	New	TT-C-00530
Creosote, Technical (AGR-FS) (Rev. FS).....	New	TT-C-00645
Drums, Shipping, Steel ICC-6A and ICC-6B (for Phosphorus, White or Yellow, Dry or in Water) (COM-BDSA).....	New	PPP-D-00736
Dust Mop Treating Compound (GSA-FSS).....	Rev.	P-D-00800a
Film, Photographic, Heat Developing (Microfilm 35MM) (Navy-Wep).....	New	L-F-00320
Film, Photographic, Heat Developing (Microfilm 35MM) (Navy-Wep) (Not. 1).....	Am. 1	L-F-00320
Film, Photographic, Microfilm (Black and White) (Navy-Wep)..	New	L-F-00334
Lime, Hydrated (for) Structural Purposes (COM-NBS) (Rev. FS).....	New	SS-L-00351a
Sealing Compound, Two-Component, Elastomeric, Polymer Type, Jet-Fuel-Resistant, Cold-Applied, Concrete Paving (Army-CE).	Am. 1	SS-S-00200a
Stain, Semi-Transparent, Wood, Exterior Oil (AGR-FS).....	New	TT-S-00708
Tape, Paper, Computing-Machine (Navy-S&A).....	New	UU-T-00110

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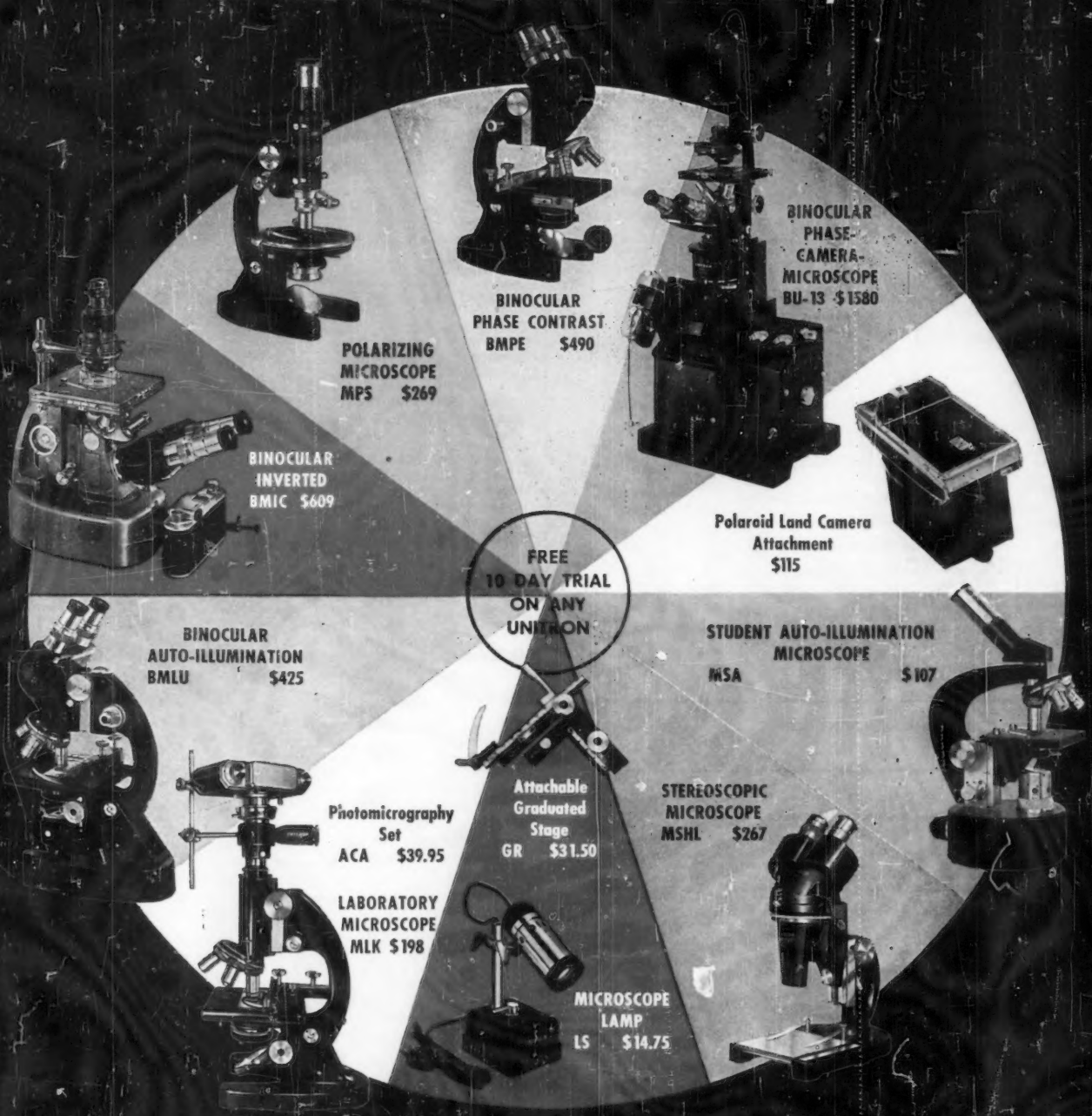
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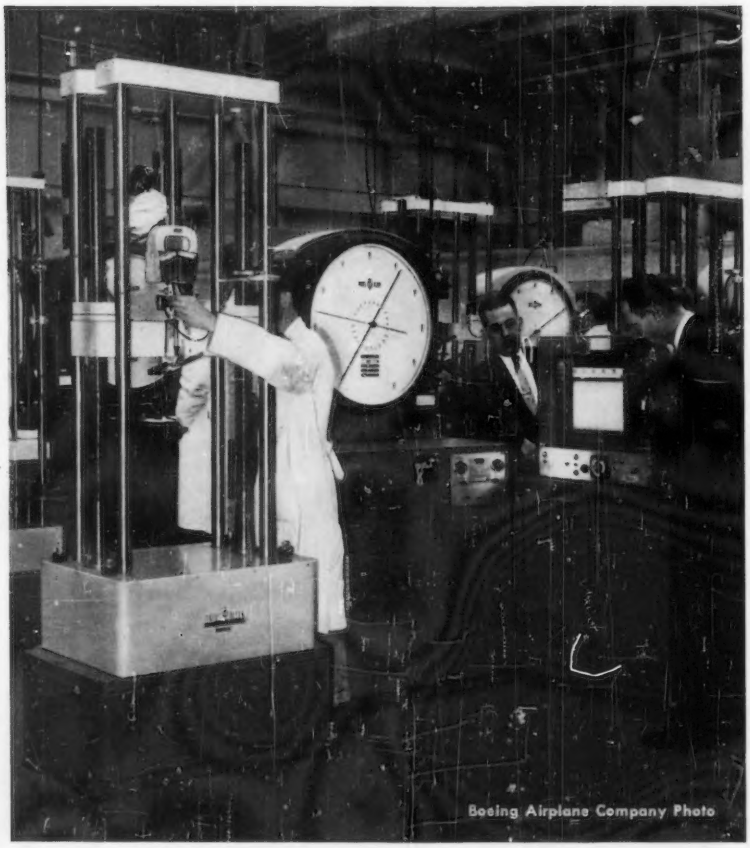

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